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ABSTRACT

Presented is the final report of a 5 year project to identify effective teaching strategies of 57 speech clinicians who worked with 1108 elementary grade children, originially with articulatory disorders, but who achieved correct articulation performance in spontaneous speech. Explained is a methodology to determine speech clinician and child characteristics, as well as interaction behaviors associated with articulation learning. Results are reported in terms of child characteristics (such as four basic learning curves were observed), clinician characteristics (such as experience, rapport), lesson plans (such as frequent use of standard drill), and the results of a tone keyboard system of recording behavior events in therapy. (BB)

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FINAL PERFORMANCE REPORT

"Training Speech Clinicians in the Recording and Analysis of Articulatory Behavior"

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I. INTRODUCTION

The global strategy of this project was to identify effective teaching programs with children who achieve correct articulation performance in spontaneous speech. The speech clinician and the child variables associated with the most effective learners were to be isolated. The project went through two phases: (1) the development of a system for assessment of articulation progress from imitation and conversation throughout the course of therapy. This was a basic demarcation from classical testing of articulation progress by evaluating the child at the beginning of therapy and at the end of therapy from single word items sampled in the initial, medial, and final positions. (2) The second major effort was to develop a methodology to describe the clinical events which occur between the clinician and the child during articulation therapy.

There were two major questions of the project:

1. After establishing a method for tracking articulation learning for large numbers of children, would it be possible to isolate unique learning patterns?
2. Would it be possible to isolate those factors which seem important for successful learning? There were four categories which seemed important for learning such as:
   a. Child characteristics (sound, previous therapy, grade, IQ, etc.).
   b. Clinician characteristics (age, years experience, degree, rapport, etc.).
   c. Therapy arrangements (number of sessions per week, number in group, etc.).
   d. Therapy procedures (cognitive lesson plan, therapy interactions, etc.).

Goals and accomplishments of each project year.

Each year some transformations of methodology were made in order to sharpen our procedures and tools for the ultimate goal of studying the therapy process in articulation learning during the final data collection year - Year IV. The six years of the project are summarized below.

Project Year I - The basic task was to determine if systematic evaluation of the child's articulation learning could be done by field clinicians in the schools. Two probes, the Sound Production Task (SPT) an imitative speech task and counting target phonemes correct/wrong during three minutes of conversation (TALK), were taken on each child on a once-a-week or every two weeks schedule. The child's articulation learning was plotted on a chart. Data were collected in the field on porta-punch IBM cards by the clinician, mailed to the project office, and machine processed at the Computation Center.

Time spent on computing SPT/TALK, charting, and punching IBM porta-punch cards was compared with another group of clinicians who used more conventional record keeping procedures, and no differences in total time were found. Reliability measures of clinician correct/wrong counts during conversation were

believed to be satisfactory. The three minute conversation provided a sufficient sample of /r/ and /s/ occurrences to reflect progress on the target phoneme. And finally, the speech sampled in three minute TALKS during therapy was found to be representative of the child's speech when sampled outside of therapy by another non-clinician adult (Year I progress report). In the first year there had been no restriction on type of sound studied, but for several reasons we chose to study only the /r/ and /s/ in the next three years. One was the high error incidence of both these sounds, secondly, the high frequency of occurrence of /r/ and /s/ in conversation (8-10 times per minute), and lastly, since we were interested in articulation learning, it was highly desireable to have two distinctly different phonemes.

Project Year II - During the first year we had used the 30 item SPT for /r/. Since our interest was in the acquisition of /r/, and its many allophonic features, the SPT was enlarged to 60 items to sample a broader allophonic range of /r/. The new 60 item /r/SPT was used in the next three project years. The 30 item /s/ SPT was not changed. The objective was to replicate the SPT/TALK probe and charting procedures on another group of clinicians and children; this time only with /r/ and /s/ defective children. Three project staff clinicians also were charged with the task of developing a procedure whereby therapy interactions between the clinician and child could be described while it was actually happening.

The new group of clinicians was as reliable in correct/wrong counting from conversation as the first year clinicians and also confirmed the minimal time expended to record the data. Further evaluation of the Talk in other speaking environments continued to confirm that no differences were found in correct/wrong counts made from TALK samples obtained in therapy and those done elsewhere (child talking with the teacher in the classroom and with the parent at home). Furthermore, a major technical breakthrough was accomplished by discovering that the behavior events in therapy could be followed by a touch tone telephone keyboard, hereafter called the Tone Keyboard (TKB). This did away with the nasty problem of writing all the interactions on paper. A Tone Keyboard was fabricated and tried during the summer months by the principal investigator and Mrs. Nancy Lamb, a school clinician. Certain modifications were recommended for a trial use by field clinicians in Year III. A system for describing the clinicians' lesson plan was also developed in Year II.

Project Year III - Nine public school clinicians tested the TKB in group therapy. A procedure had been detailed whereby they entered their cognitive lesson plan on the TKB before each session. Since, at this stage of the project, TKB decoding was not found to be perfectly reliable, a paper-pencil format was derived to enter the clinician's cognitive lesson plan in Year IV. The therapy interaction behaviors of the clinician and child, as described by our coded system, could be entered during therapy by the clinician on the Tone Keyboard. Audio tapes, recorded from the Tone Keyboard, could be reliably decoded at a later date at the Computation Center. The TKB was judged by the clinicians as a workable instrument to describe the therapy events with minimal interference in therapy procedures. There were obvious shortcomings, but the TKB system seemed the most viable procedure we had tried. After developing this TKB procedure we discovered that an instrument with a similar purpose, using newer electronic technology called DATAMYTE had been developed (1969).

Project Year IV - Now we had a system for tracking children's articulation learning over the school year and what appeared to be a useable system for describing the clinician's lesson plan and the interactions with the child during therapy. Our strategy was that by knowing which child achieved success or not we could then go back and analyze the clinician's lesson plans and behavior during therapy. In this manner it might be possible to determine if there were similar teaching strategems and behaviors across clinicians and children.

If "principles" of therapy management were to be discovered that had across clinician-child viability, we believed it desireable to select clinicians and children from a larger geographic area. Therefore, since our first three years had been primarily with clinicians and children from the Greater Kansas City area, we chose clinicians and children from three different locations: Minneapolis, Minnesota; Wichita, Kansas; and Jefferson County, Colorado (outside Denver).

To make our evaluation of the children more comprehensive, we gathered additional information about each child such as their ability in auditory discrimination, language, and school achievement. In addition we developed a procedure to evaluate the daily feelings of the clinician and child before and after each therapy session. All of this information was mailed to us, key-punched, and stored for data analysis.

Project Year V and VI - The tremendous amount of data which had been collected during the past four years were analyzed. There were two major analyses. Realizing we had three years (II, III, IV) of data with the same measures of speech progress, 30 item /s/, 60 item /r/ SPT, and Three Minute TALK for over 1400 /r/ and /s/ children, we decided to do two major analyses (1) over three years of the project and (2) a detailed evaluation of the more comprehensive Year IV data on 250 children. Some special aspects of the data were given additional analysis and also reported.

1. Analysis over the three years.
   (a) The SPT/TALK was used as the source of the main dependent variables on all the children.
   (b) Independent variables for all children were available such as sound, sex, grade, previous therapy, sessions per week, number in group, project year, and geographical location of school.
   (c) On the 57 clinicians the following independent variables were available: age, years experience, education, ASHA certification, self-ratings about their clinical skills and ability to discriminate /r/ and /s/ phonemes, and an educational opinion inventory (EOI) indicative of rapport.
2. Detailed evaluation of the comprehensive Year IV data.
   (a) Additional child characteristic variables were included such as auditory discrimination, language ability, school achievement, and socio-economic status.
   (b) Clinician cognitive lesson plan.
   (c) Interactions of the clinician and child during therapy.
   (d) Daily feelings of the clinician and child.

II. METHODOLOGY

A. The development of a system for tracking children's articulation learning over time (the dependent variable).

Would it be possible to develop an on-line procedure for obtaining a speech progress readout? The procedure would be a basic demarcation from the classical single word, articulation testing, of the child at the beginning and end of therapy. The tasks should be capable of being cheaply administered, in short periods of time, at frequent intervals, to large numbersof children in a school system. In addition, the probes should reliably reflect the child's total speech ability at any given moment in time, and optimally, reflect that speech in all speaking environments. These measures, if plotted graphically, could provide a visible record of progress for clinician, child, and parent. And finally, we believed that if more sensitive measures of articulation learning could be developed then, perhaps, differences in children and/or therapy procedures could be more easily discerned for predictive purposes.

Systematic probing of the target phoneme by both imitation and conversation were developed in Project Years I and II. One of the measures, the Sound Production Task (SPT) was comprised of sounds, words, and phrases spoken by the clinician and imitated by the child (Elbert et al., 1967; Shelton et al., 1967; and Wright et al., 1969). There were 30 items for /s/ and 60 items for /r/. The second measure was a three minute sample of spontaneous speech between clinician and child where the clinician counts the target phoneme Correct or Wrong while the child is talking (Diedrich, 1971 , 1972b). Children who were in therapy once/week were probed once/month, twice/week were probed every other week, and in block therapy (four times per week) probed once/week. In this manner the SPT/TALK probes were given during every fourth therapy session.

In a paper reported by Diedrich and Bangert (1972), the concept of a Unified Score was presented (Figure 1). By combining the correct and wrong counts from the imitative articulation task (SPT) and from conversation (Three Minute Talk) a percent Unified Score was derived. The Unified Score was the total number of phonemes correct on Talk and SPT over the total number correct and wrong. Drash et al. (1970) have discussed the reliability and sensitivity of using correct and wrong counts as a dependent variable in speech. Thus, the Unified Score can be computed at any time throughout the school year by giving the child SPT/Talk.

Examination of the imitative and spontaneous speech tasks used for this study yielded a positive correlation of .79 between the children's mid-year SPT scores and TALK mid-year scores. It would have been possible for us to analyze SPT and Talk separately, but there is likelihood of obtaining similar results. Therefore, each pair of scores was combined in the Unified Score, resulting in an articulation score which represents both imitative and conversation skill for a given target phoneme.

Some of the advantages of the Unified Score are first, combining two scores results in more information being contained in one number. It is a more

reliable predictor of the total speech behavior than a single number. Second, adopting the use of one number should facilitate improved communication among speech pathologists. This concept is similar to that of I.Q. scores which combine verbal and performance skills and other indices such as Gross National Product. Third, the Unified Score would provide for comparability of results. One criticism of behavioral scientists has been that perhaps they spend too much time devising new tests and too little time carefully discussing comparable results across different clinicians and children. Fourth, the Unified Score aids in clarification of complex data analyses since it is easier to deal with one variable rather than several. The fifth and last advantage to economy of effort in time and money. It is very tedious and costly to work with both numbers on large amounts of data (even in the computer world!).

Although the McDonald Screening Deep Test of Articulation (1968) was given to all project children at the beginning, middle, and end of the school year, it was not used as a dependent variable in the overall analyses strategy of the combined project years. Several compelling reasons dictated this decision. Analyses of data in Year II showed pre (September) McDonald Total Error scores correlated with mid-year January scores (.79) and post-test (May) Total Errors (.65), but only -.22 with post-test TALK. Another formidable difficulty is how to quantify the phoneme errors detected on any articulation test for an overall measure of severity, i.e., are all phonemes equal in weight and how do you weigh errors of omission, substitution, etc.? McDonald (1974) told us that his investigations of an overall articulation severity score (over several phonemes) had not been predictive of any future articulation learning on a given phoneme error. Another limitation was that we were interested, as described above, in more continuous learning measures of a specific target phoneme. Also, since the McDonald Screening Test evaluates nine different sounds it did not lend itself to the systematic probe measures in which we were interested. We could use the McDonald Deep Test (1964) for sampling /r/ and /s/ improvement, but we were using the Sound Production Tasks (SPT) which provided an in-depth analyses of a given phoneme and did not take nearly as long to administer. See Section IV for an analyses of the McDonald data.

B. Standard Measures (Independent Variables)

Informational questions were asked of all clinicians and children who participated in the project. These will be indicated below and are not detailed any more than is necessary for explanatory purposes.

1. Clinician characteristics.
   a. Age
   b. Sex
   c. Education (BA or MA)
   d. Years experience
   e. ASHA Certificate of Clinical Competence (Yes, No, Pending)
   f. Self-concept on:
      (1) discrimination of /r/ and /s/
      (2) ability to teach /r/ and /s/
      (3) ability to teach /r/ and /s/ in comparison with other clinicians

Item f. was accomplished by having the clinicians circle on a one to five scale from poor to excellent their abilities.

g. Educational Opinion Inventory

We were interested in obtaining an evaluation of personality or attitude of the clinician. We did not want to use obvious psychological measures such as the MMPI or California Personality Scale. In searching for a suitable instrument we found the Educational Opinion Inventory (EOI) by Krasno (1972) developed at the Stanford Center for Research and Development in Teaching.

> A scale was evolved from the 300 EOI items with related EOI responses to the criterion variable of teacher-student support (R scale). The purpose was to identify a set of items which would differentiate between prospective teachers who could establish immediate rapport with students as measured by the Pupil Inventory and prospective teachers who were not successful in establishing rapport. The validity of each EOI item for inclusion in the R scale was thus defined as to the degree which it differentiated between two groups of potential teachers (p.44).

The 62 items which differentiated teachers with high and low rapport were administered to all clinicians. If the Educational Opinion Inventory (EOI) were an indicator of the speech clinician's ability to establish rapport, would it be possible to show that speech clinicians who were successful with modifying /r/ and /s/ phoneme behavior were also the ones with high rapport as measured by the EOI scale? Furthermore, since we were measuring the clinician's daily reelings, we would try and correlate the EOI rapport measure with daily feelings and see if it would be a predictive test. Since the EOI was not discovered until after Project Year IV began, it was administered to all project clinicians from Years II, III, IV, in the spring of Project Year IV.

2. Child Characteristics
   a. Sex
   b. Grade
   c. /r/ or /s/ sound
   d. Weeks of previous therapy on /r/ and /s/
   e. Number of children in therapy group
   f. School Record Information (Year IV only)

School Achievement Tests in reading, spelling, arithmetic were pulled from the child's school records. In different school systems, different tests were used (even within the same city). However, a basic decision was made not to attempt to teach the speech clinicians to give a standard school achievement test (for example, the Wide Range Achievement Test) to the children. The compelling logic was that we would probably be able to obtain a better in-depth index for a given academic area by using the school tests whether they be from the Stanford Achievement Test, Gates Reading Test, etc., than could be obtained by a survey instrument such as the Wide Range Achievement Test. Therefore, the percentiles used for reading from the school records actually reflect several different tests. The most recent score was used if more than one existed. It was interesting to note that despite the geographic differences many of the schools used the Stanford Achievement Test in reading.

School records were too incomplete to obtain information on spelling and arithmetic. In addition to the achievement tests, we requested information on intellectual tests that might have been given, but again, too few children had complete intellectual tests so this item was abandoned.

Additional questions were asked regarding the child's family and whether or not they had speech problems; whether the parents were deceased or divorced; whether they came from a minority group, and whether or not the child was from a low income group (less than $5,000 per year). This information was obtained from school personnel, records, and from personal contact the clinician might have had with the family . Formal interviews, as such, were not held with the parents. Therefore, many of the responses were "don't knows".

g. Auditory Discrimination (Goldman-Fristoe-Woodcock, subtest in noise)
h. Tongue Thrust and Dental Evaluation
i. Language information (a) Peabody Picture Vocabulary Test, (b) Token Test (Part V), (c) Detroit Test (Auditory Attention Span for Related Syllables)
j. McDonald Screening Deep Test of Articulation
k. Sound Production Task (SPT)
l. Three Minute Talk (Correct/Wrong count)
m. Clinician-child interactions.

In project years II and III we developed categories which described the therapy events. In developing the procedures for recording clinician behaviors we were interested in generating a system that could be operated entirely by the clinician and literally come from the therapy session itself. We did not want to interview the clinician about what she did after the therapy occurred, nor did we want to make tape recordings, nor did we want to make video tape and have to go back and listen and make a description after the fact, and finally we did not wish to place an observer in the room to make notes about what was going on. Each of these has many problems in terms of cost, time, and in the instance of an observer in the room, lends another person to the total interaction which we did not want. The solution to our problem came in the form of two separate procedures. The first was the development of the cognitive lesson plan and the second was a description of the clinician-child interactions during therapy.

1. Cognitive Lesson Plan

Prior to therapy each clinician has some idea of what she plans to do and we simply wished to put on paper, in some formal descriptive manner, her cognitive plans for each of the children. This became known as the CHILD IDENTIFICATION AND ACTIVITY sheet (or lesson plan) which each clinician completed prior to the therapy session (when necessary the clinician could change her plan while the therapy occurred).

The ACTIVITY is the chronological order of the stimulus materials which will be provided for the child during the therapy session (the cognitive lesson plan). The ACTIVITY information was recorded by paper/pencil procedures and mailed each week to the project office to be key punched for computer analysis.

2. Behavior of the clinician and child during therapy.

The cognitive lesson plan provided us with a skeletal outline of what the clinician intended to do. The outline does not report what she actually did. We needed a different procedure for obtaining the information about the specific behaviors which the clinician and child performed. After many trials and tribulations a system was developed which described the INTERACTIONS which occur between the speech clinician and the child. The specific second-to-second stimulus which was provided by the clinician, the response of any given child in the group, and the consequation by the clinician were described. The clinician described the therapy process as it actually occurred. We have developed two ways of obtaining this information: (1) a paper/pencil procedure which has been used by undergraduate students at the University of Kansas during their school practicum and by some supervisors; (2) For the Year IV Project, we used an electronic system known as the Tone Keyboard which literally allows the clinician to act like a court stenographer and record what she and the child did as therapy actually occurred. The telephone touch-tones were tape-recorded and then later decoded at the Computation Center.

C. Selection and Training of Clinicians

In Years II and III we utilized speech clinicians in the Greater Kansas City area (Missouri and Kansas). Clinicians in the area were invited to participate in a research training project. Twenty were chosen who represented a cross-section of school district size and socio-economic areas. Twelve different school districts were represented. There were 18 females and two male clinicians; three were black.

Three part-time staff clinicians also were added to the project. Each worked twice a week with a caseload of 20 children in the public schools. The primary goal for the three staff clinicians was to develop a methodology for describing therapy procedures as therapy was in progress.

Prior to the school year all clinicians received training in counting and charting target phonemes from conversation. Practice was provided in administration of the McDonald Screening Deep Test of Articulation, Sound Production Tasks, and tape recording of conversation for future reliability checks. They also were taught how to use the IBM porta-punch cards and given instructions on mailing the data to the project office.

Data was collected on the IBM porta-punch cards during the first three years of the project. In Year IV it was not used because the clinicians had to master the operation of the Tone Keyboard. We did not want to add another new "system" of data collection on top of that and deemed it wiser to obtain SPT/TALK data via conventional paper/pencil methods which later were key-punched at the Computation Center.

In Year III nine clinicians in the Kansas City area collected data on the Tone Keyboard. The purpose of this group was to refine the therapy data collection procedures in actual field conditions and determine if the methodology could be utilized on a larger scale in the last project year.

In order to have a control group of clinicians and children who were not

counting and charting, in Year III a group of nine new clinicians consented to have our staff clinicians administer SPT/TALK tasks to their caseload. This enabled us to have a group of children who were not receiving any regularly administered SPT/TALK tasks, nor were they having their progress systematically charted by the clinician every other week. These nine clinicians received no training in any of the project procedures.

To obtain a broader distribution of clinicians and children in Year IV we selected three new cities. Personnel in the school districts of Wichita, Kansas; Minneapolis, Minnesota; and Jefferson County, Colorado (outside of Denver) were invited and agreed to participate in Project Year IV. A total of 30 field clinicians (10 from each city) who performed therapy on a twice-a-week schedule were selected for training. The coordinators of these three school districts were asked to choose clinicians who represented a diverse educational background, with a varied number of years experience, and who utilized different models and procedures in conducting their therapy. These were persons, in the coordinators' estimation, who had provided successful therapy to children. There were 27 female and three males, all were white. They worked with children in urban, suburban, and rural areas which represented all socio-economic levels. During March, 1972, we conducted workshops in each of the three cities instructing the 30 clinicians on how to use the Tone Keyboard. They received approximately six to eight weeks practice during April/May in preparation for their participation during the next academic year, September 1972 - May 1973 (Project Year IV). From our experience with the nine clinicians who utilized the Tone Keyboard (TKB) during Project Year III, it was found that they became fairly comfortable with the TKB after six to ten hours of practice while conducting therapy. The clinicians during this period also practiced how to count target phonemes during conversation (our three minute Talk task) with their children.

In August, just prior to the beginning of the school year, a two day workshop was scheduled in each of the three cities. During this time the following topics were presented and reviewed: selection of project children, scheduling of tests, learning how to complete the Child ID, Activity and Feeling sheets, review Tone Keyboard procedures, and finally, all of the tests which were to be obtained on each child were presented and use of these were practiced at that time (for example, the Goldman-Fristoe-Woodcock Auditory Discrimination Test, the Token Test, etc.). In addition, specific administrative procedures were outlined for the submission of their testing materials, obtaining probes, and the weekly mailing of Tone Keyboard tapes, Child ID, Activity and Feeling sheets, and SPT/TALK sheets to the project office. Each clinician was given a five inch reel-to-reel tape recorder and its use was carefully reviewed. A workbook was prepared for each clinician detailing all the steps and tests procedures. When school began that fall we had 10 participating clinicians from Wichita, 10 from Minneapolis, and seven from Jefferson County for a total of 27 clinicians.

About the first of November another one day workshop was held with the clinicians in each of the three cities to review their testing materials, schedules, and to answer any questions which had developed regarding total project operation. Reliability checks on their use of the Tone Keyboard also were made at this time. A coordinator was chosen among the clinicians in each city so that questions could be channeled through this person and communicated to the project office for answers. Since many of the clinicians had similar questions, this was an efficient way to manage many of the problems. However,

each of the clinicians had direct access to the project office via telephone or mail; if they had specific queries they could have these answered promptly.

A third contact was made with the clinicians during the latter part of January and at this time mid-year checks and evaluations were reviewed that were necessary for the project. Additional questions and problem solving that are expected in a project of this scope and size were covered at this time.

Finally, the last one day workshop was held in the beginning of May to review the end-of-year tests, and provide the clinician with extra forms and materials which might have been expended during the year. The Educational Opinion Inventory was administered at this time to all clinicians and they completed a questionnaire about their participation in the project. Questions were asked regarding how they felt about the use of the Tone Keyboard and its contribution to their clinical skills. The questionnaire was a subjective but useful piece of information.

D. Selection of Children

Clinicians were instructed to select children with /r/ or /s/ errors. Children with other phoneme errors were acceptable for project study as long as the /r/ or /s/ was the primary error and one which, in their opinion, required therapy. From data analyzed in Year II we determined that using the selection procedures described below only 11% of the children (N=584) had errors on both /r/ and /s/, i.e., more than three errors on the /r/ and more than three errors on the /s/ (each sampled with 10 items) on the McDonald Screening Test. In other words, most children have errors on one or the other phonemes, not both phonemes.

In Year II each clinician submitted to the project office their scheduled caseload of /s/ and /r/ children who were grouped separately. We chose the groups so that each clinician had a total of 30 children in the project (15 /r/ and 15 /s/). We started with third grade children and then went 4th, 2nd, 5th, 1st, 6th to fill out the N=30 for each clinician. During Year III, because the Tone Keyboard was being used, each clinician had about 20 children in the project. The same children selection procedure was used.

In Year IV we wanted to determine whether there were differences in teaching approaches with children who had a year or more of therapy compared with children who had no previous therapy on that phoneme. Therefore, we chose four groups of children, two /r/ and two /s/ groups, one /r/ group and one /s/ group had previous therapy, one /r/ group and one /s/ group had no previous therapy. It had been noted in our pilot Year III that the use of the Tone Keyboard was comfortable with two or three children in a group, but four children in a group overloaded the system. Therefore, each clinician had approximately 10 children for whom she collected data.

From our preliminary data analysis little difference in articulation learning scores was observed from therapy conducted once-a-week, twice-a-week, or block scheduling. Therefore, in Year IV, we chose to select children who were seen twice-a-week since this seemed to be the more common practice across the country (Bingham et al., 1961). Each clinician's groups were composed of

two to three children from grades one to five who were seen on a twice-per-week schedule. Each clinician completed an ID-ACTIVITY sheet on every child for each session and then used the Tone Keyboard (TKB) during the therapy session to describe clinician-children interaction. Based on the experience of the nine clinicians piloting the TKB from the Greater Kansas City area during Year III we had found that the clinicians should use the TKB a minimum of twice a week to maintain their skills. In addition, the clinicians observed that it was not efficient to try to use the TKB for every therapy session in any given day. Four hours a week seemed to be a comfortable amount to handle. Consequently, establishing the use of the TKB on a twice-a-week basis for four groups amounted to about four hours per week of therapy data being collected in that manner.

The requirements for selection of the children were the following:

1. HEARING - the child was not labeled by the parent, teacher, clinician, nurse, or physician as having a hearing loss. No more than an average of 20 dB loss may be present in the better ear at 500-2000 Hz if audiograms were available.

2. SPECIAL EDUCATION - the child was not in Special Education class and was not identified by a physician or school system personnel as a cerebral palsy, mentally retarded, emotionally disturbed, or hard-of-hearing child. A child classified as "learning disability" could be included if he attended regular class (only a few were included in this classification).

3. COMBINED SPEECH PROBLEMS - in the opinion of the speech clinician, if articulation (/r/ or /s/) was the primary problem being treated, a child with voice, stuttering, or language problem was acceptable.

4. AGE - children in grades second through fourth were preferred; but first, fifth and sixth graders were included when the N was too small.

5. ORGANIC - any child whose articulation problem appeared to be caused by a physical defect was not included, e.g., cleft palate or diagnosed central nervous system disease.

6. ITINERANTS - eliminate children of families who were subject to almost certain moves as seen in their past histories during the school year.

7. FAMILY RELATIONSHIPS - no selection of twins, only one sibling from the same family could participate in the project.

SUMMARY OF RELIABILITY

1. Satisfactory reliability does not depend upon typescripts. Groups (four or more) of persons (clinician, non-clinician, etc.) can make reliable correct/wrong judgements (live or taped) of children's conversation (interreliability .70's to .90's, but only .54 for any individual). These are audio samples of speech from children unknown to the listener.

2. Clinician judgements of children they treat in therapy may be low (.30's to .70's) when compared to other observers (clinicians or non-clinicians). Frequency of total sounds heard in conversation are usually judged the same. After children have been in therapy (mid-year or later), clinicians judge more correct and fewer wrong than the other observers.

3. Clinician's judgements are usually less reliable (stable) at baseline (.60 for /r/ and .30 for /s/) than at mid-year (January samples were .76 for /r/ and .49 for /s/). Demonstration of temporal effect and developing self-internal standard.

4. Reliability judgements made from tape of /s/ are usually less stable (reliable) than /r/. Clinicians frequently counted /z/ for /s/ and poor audio tape fidelity are contributing factors.

5. Better reliability was obtained with the clinician in the live therapy situation than from tape observations.

6. Reliability of imitative Sound Production Tasks (SPT) was higher than for samples of conversation.

7. Once a correct/wrong standard is developed by a judge it remains relatively stable even after many hours of additional judgements carried out for short periods of time (25 hours in one week) or longer periods of time (66 hours over 11 weeks).

8. Judgements on derived scores (baseline to mid-year gain scores) show that nurses agree with clinicians that improvement is observed.

9. Reliability measures judged on children in therapy between clinicians and neutral observers may be low, but high reliability does not preclude experimenter bias (Kent et al., 1974).

10. Evidence that the corrected phoneme generalizes to speaking environments outside of speech therapy was obtained. Speech improvement claimed by the clinician in therapy was judged by other observers to be maintained in other speech environments.

These reliabilities fluctuate a great deal and frustrate the investigator who wishes to demonstrate "high reliability". During a four year period we accumulated weekly and monthly records of articulation learning on over 1500 children and 57 clinicians during the school year from a four state region. Despite the apparent rubber yardstick of clinician correct/wrong judgements most children do improve as demonstrated by non-clinician observers. There is a sense of stability or validity as seen by the replication of results in our data during this time. Also, the results seem to make sense and all this contributes to believeability of the data.

Therefore, we are willing to accept the fact that point for point agreement for any given child at any given time by any given group of clinicians or judges will be less than perfect for correct/wrong counts made during conversation. Clinical investigations should continue with the realization that the aseptic condition of the laboratory or statistical elegance of the agronomist's latticed field work will not usually obtain. Even with all the loopholes of clinical reliability, progress is being made and suggestions

regarding articulation treatment should be given with the best evidence available.

A quote from Kenny (1975) seems appropriate here:

> We would all prefer to have the testimony about an event from a sighted man over a blind man. But when we have only the blind man, we would not dismiss his testimony, especially if he were aware of his biases....
>
> The difference between the true experiment and the quasi-experiment is of the magnitude of the difference between sight and blindness. We must often grope in the darkness with quasi-experimental designs, but this blindness both forces us to compensate for biases and helps us develop a newfound sensitivity to the structure of the data. Finally, it makes us appreciate the clarity of true experimental inference.

III. RESULTS

The first phase was concerned with accountability, that is, teaching school speech clinicians to accurately assess the change in speech responses which children made over time. Clinicians were taught to count articulation responses from imitation (Sound Production Task) and during spontaneous conversation (a three minute Talk Task between clinician and child). Learning curves of the speech progress were derived from these percent correct scores made every two weeks throughout the school year. Data was analyzed on 57 clinicians and 1108 children from grades one through six. Only children with /r/ or /s/ errors were analyzed. The average /r/ child had eight errors out of 10 items on the McDonald Screening Deep Test of Articulation. The average /s/ child had eight errors out of the 10 items.

A. Dependent and Independent Variables.

Scores from SPT and Talk were combined to form a Unified Score (percent correct) throughout the school year for all three project years. Estimated Unified Scores were created by averaging Unified Scores. Summary data were generated on four EU numbers: EU1 - Baseline, EU2 - after six weeks of therapy, EU3 - after 18 weeks of therapy, and EU4 - at the end of the school year after 30 weeks of therapy. Three other values were computed: GAIN (EU4-EU1); GAMMA (3+2-4-1) is a number which reflects the rate of learning (it is not a percent correct score); and LEVEL is an average of all four EU numbers (Figure 1).

Thus far we have been able to isolate four distinctive learning curves for 45% of the children. We have named the four learning curves KLMO; the letters KLMO refer to type of curve, not to phonetic error (Fig. 1).

K = High positive GAMMA (greater than 50).
L = High negative GAMMA (greater than minus 10 and GAIN greater than 50% correct.
M - A near zero GAMMA and LEVEL is greater than 75% correct.
O = A near zero GAMMA and LEVEL is less than 30% correct.

Independent variables studied included clinician characteristics (experience, age, degree, ASHA CC, self-concept, rapport), child characteristics (sound, sex, previous therapy, grade, I.Q., Reading, Token, Detroit, GFW, dental) and therapy arrangements (number of sessions/week, number in group).

B. Results for /s/ vs /r/:

Table 2 summarizes the learning for /s/ and /r/ children (n=1108). Both groups started out with the same baseline (EU1) percent correct scores, but /s/ by the end of six weeks is ahead of /r/ and remains there throughout the school year. /s/ children also made significantly more GAIN, GAMMA, and LEVEL.

The lower half of Table 2 indicates EU values (percent correct) for the children followed in Year IV. Again, /s/ showed significantly greater learning. There were no differences in Therapy Arrangements between /r/ and /s/ children. We are not able to see in this table any factor which would

cause the /s/ - /r/ learning differential. The two groups were not different on Peabody Picture Vocabulary Test I.Q.'s (PPVT), Goldman-Fristoe-Woodcock (GFW) auditory discrimination subtest in noise, Detroit (Auditory Attention Span for Related Syllables), Token Test (Part V), standard Reading Tests administered in the schools, diadochokinetic rate (repeat /da/ in 15 seconds), or the number of Dental Problems observed by the clinician (open bite, overjet, edentulous, etc.). The /s/ children did have more indices of Tongue Thrust (measured on 11 items) and /s/ had more Open Bite (space between upper and lower incisors).

C. Results for KLMO:

Although no differences were found between /s/ vs /r/ learners, we did find differences when children were compared on type of learning curve. Table 3 summarizes a set of chi-square analyses. Each analysis relates the dependent variable KLMO to one of the independent variables. The last column gives the significance levels for each chi-square. The first four columns are used to summarize the body of the table. We have looked at each chi-square component for each cell. Where the component is larger than 4.0, this is indicated by "too many _____" meaning the observed value is larger than expected or "too few _____" meaning it is smaller than expected. This way, we indicated just how the table differs from the independence hypothesis. For example, looking at GRADE, KLMO is significantly related to GRADE because there are too many first graders among L children and two few first graders among M's.

To summarize the results of Table 3 one would conclude that the fast K learners were primarily composed of /s/ children in third grade with no previous therapy who received lessons four times a week (block therapy) from ASHA-CC clinicians. Sex, number in group, and degree had no effect. The slow moving O learners were mostly /r/ children in all four grades, with no previous therapy, seen once a week by clinicians whose ASHA-CC was pending. L children had more first graders, had fewer four in a group, and were treated by more MA clinicians and fewer BA clinicians. The M children were older (4th grade), had previous therapy, too few groups composed of three children, and treated by more BA clinicians and fewer MA clinicians. The effects for clinicians' degree (BA or MA) with L-M are not strong.

In the ANOVA analysis for continuous clinician variables (Table 4) the most surprising finding was that years of experience was not significant. Older clinicians were associated with K and younger clinicians with O-M learners. The clinicians were asked to judge themselves on ability to discriminate /r/ and /s/ sounds, teach /r/ and /s/, and compare themselves with their colleagues on teaching ability for /r/ and /s/. This was called SELF R and SELF S and both were significant. K learner's clinicians believed they were good at discrimination and teaching /r/ or /s/. And finally, on the Educational Opinion Inventory (EOI), a paper-pencil attitude test of educational practices which is reported to reflect degree of rapport with children (Krasno, 1972), the K learners had clinicians with higher rapport scores than O learners.

Child characteristic data were obtained only from Year IV (Table 5) so

the N is much smaller. Several child variables were not significantly different; Auditory discrimination (GFW noise subtest), presence of tongue thrust (total of 11 items), and diadochokinesis. Children with K curves generally had higher (better) language scores than both the LMO learners as well as the entire group, as evidenced by the Peabody I.Q. score, percentile reading scores (whatever one was used by that school), the Token Test (Part V, comprehension of certain grammatical concepts), and the Detroit Test (subtest, Auditory Attention Span for Related Syllables).

Compared to K the M-C children generally had lower I.Q., the O was lowest in Reading, the L-M-O were lower on Token Test, and L-M lowest on Detroit. Slight effect for L to have fewer dental problems (Total Dent.) such as overjet, underbite, open bite, edentulous spaces, interproximal spaces, and irregularly placed teeth. Except for the Detroit, the O learners were not only below the mean for K, they are below the mean for all Year IV children combined (n=194). The small numbers represented by O here caution the negative statements about this group; however, the larger N in K gives more strength for that group.

It may be that clinicians' years experience and educational background are relatively unimportant. However, clinician age, ASHA certification, self concept, and the ability to establish rapport with children were associated with children who learn quickly (K learning curve). The number of therapy sessions per week also seemed important. As far as child characteristics is concerned, those with better language scores (Peabody, Token, Detroit, and Reading) seem to learn faster (K curve). Auditory discrimination, tongue thrust, and diadochokinesis all appeared relatively unimportant determinants of articulation for these children.

It is of interest to note that when /s/ and /r/ children were compared none of the child characteristic factors differentiated the two groups (with the exception of open bite and tongue thrust which might be expected). However, when types of learning curves (KLMO) are now made the dependent variable, then several child characteristic factors emerge as differentiating variables.

D. Prediction of Learning:

One of the objectives of the analysis was to try to determine which variables would give us the best prediction for a child's overall articulation GAIN and/or rate of learning (GAMMA). Table 6 illustrates an ANOVA done on the dependent variables GAIN and GAMMA. The independent variables were Sound-Baseline category (SNDEU1) that is, what was an /s/ or /r/ child's percent correct and baseline category (high, medium, or low), Grade level (first, second, third, fourth-fifth-sixth combined), and whether or not he had previous speech therapy.

The analysis indicated that these three variables (SNDEU1, GRADE, and PREVTH) accounted (R^2) for 40% of the GAIN and 15% of the GAMMA. In this analysis whenever the effect is double the standard error (SE), the interpretation is that this variable is making a significant contribution to the effect.

It can be predicted then that if a child is /s/ low, he will make 26.8% more GAIN than all other children; he will also have the best GAMMA score (12.9). /r/ low children will not make a significant GAIN (1.6) compared to all treated children and will be significantly poorer in their rate of learning (GAMMA = minus 7.8).

To see the effect of grade on GAIN and GAMMA note that third graders have the best effect (3.8) and its more than double the standard error (1.5). Third graders also have the fastest learning (GAMMA 3.8 and SE 1.6).

The conclusion from this analysis is that children with /s/ errors with low percent correct (less than 10%) at baseline and who have not had previous therapy can be expected to make the most GAIN and in the shortest possible time (hi GAMMA). On the other hand, children with /r/ errors who have high percent correct (greater than 60% correct) at baseline, will make the least amount of GAIN (-21.1). /r/ low children will make the slowest progress (GAMMA - 7.8).

Third graders will make the most GAIN and in the shortest amount of time. These data refute the commonly held notion that younger children will learn more and faster than older children. It provides clinicians with empirical support that waiting until third grade will not necessarily mean that learning will be slower or the amount gained less. The data showed that first graders made significantly slower progress than all other grades (GAMMA - 5.0, SE 2.2).

Previous therapy was not an "additive" process. Once you have had therapy it is not certain that you will do better or learn faster. In another analysis we have demonstrated that for all children combined by the end of the school year previous therapy as a single variable had no effect. Although percent correct scores for children with previous therapy were significantly higher at baseline (35% correct) than children with no previous therapy (21%), by the end of the school year there were no significant differences between the two groups (77% and 76% respectively).

E. Clinician Daily Lesson Plan and Articulation Learning:

1. All data from Year IV.

As described in the Methodology section, 27 clinicians completed a form which detailed their cognitive lesson plan for each child for every therapy session during the year. Data were mailed each week to our project office where it was keypunched on IBM cards for computation purposes. Descriptions of lesson plans were gathered on some 212 children for over 19,000 activities for that year. The absolute and relative frequency of the category is indicated in Table 7. The ACTIVITY name with the highest occurrence is #12 - Standard Drill (20.2%), followed by #1 - Free Conversation (13.4%). The next most frequent were the standard probes used to measure our dependent variable over the school year, #26 - TT (10.2%) and #27 - SPT (11.7%). This was followed by #13 - Game Drill (7.9%), #10 - Chart Time (5.0%), and #2, Structured Speech (4.7%).

It can be seen from this tabulation that #17 - Discrimination and #18 - Self-Monitoring made up only 3.2% of the activities. Since Van Riper's book (1963) has been used as a basic text since 1939, it was surprising to find

that his cardinal step in ear training was apparently not utilized very often. Or, if listening skills are important, clinicians believe that discrimination training can be accomplished in a very few trials.

Another observation was that these public school clinicians certainly did not spend much time with parents or teachers, either in training or conference. The notions of Transfer Drill, Rate Drill, Negative Practice, and Response Shaping were seldom used by these clinicians. Fun Time - a period when clinicians engaged in a game activity which was not speech structured - also was used rarely.

The STIMULUS categories used by the clinicians are detailed in Table 8. The most frequent item was Child Generated (24.6%). This means that the clinician did not provide a specific stimulus (e.g., pictures) and the child was expected to "make-up" the words or sentences. Use of Pictures (23.87%) was the next most frequent stimulus followed by Graphic (21.21%) and then Auditory Model (20.99%). A surprising stimulus was Model and Picture which occurred 2.55% of the time. It was believed that Auditory-Picture occurred more than Pictures alone, but clinicians apparently permit children to self-initiate the word more often than they expect imitative (echoic) behavior.

The CONTENT categories are listed in Table 9. The Phrase/Sentence (53.96%) occurred the most which to us was surprising. This indicated that clinicians do provide a lot of practice with more than just words. Phrase-sentence drill should be most useful in establishing carry-over of the target phoneme into more complex linguistic contexts. Words were second most frequent at 33.45%. Isolation (4.87%) and Syllable (6.21%) make up the remaining content categories.

The POSITION categories are in Table 10. The Mixed position (i.e., the target phoneme is in the initial, medial, final, or blend position) was by far the most common at 69.71%. Initial position (17.96%) was second; the Final (6.55%) and Medial (3.24%) were next. These data suggested that clinicians typically start training the /s/ and /r/ phoneme in the initial position and then switch to the Mixed position. The Medial and Final positions were not frequently used as discrete programming steps. This point will be discussed again in more detail after the next section.

2. Selected KLMO Analysis

We had analyzed all lesson plans for the entire year. The next step was to determine if differences in cognitive lesson plans would emerge when summarized for the different KLMO learning curves. We also had the problem of summarizing the data -- how can you describe the progression of lesson plans across time? We attempted to solve this by summarizing the data according to EU1-2 (first six week), EU2-3 (next 12 weeks), and EU3-4 (last 12 weeks).

Extracting the data from the voluminous computer printouts had to be done by hand and we were limited in time and money. We selected only those children who we believed would maximize our information about the type of proposed teaching procedures used by each clinician. In looking at our available data

we had for /s/, 16 K, 8 L, 20 M, zero 0, and for /r/, 3 K, 14 L, 14 M and 7 0 children. This also permitted our comparing the /s/ and /r/ L curves. We wanted to get a cross-section of clinicians so that, too, was considered in the selection. Seventeen different clinicians were represented ss can be observed in Table 11. Several clinicians (#39, #42, #62) had K /s/ and L /r/ curves. Two clinicians (#46, #48, had L /s/ and O /r/, and one clinician (#48) had L /s/, L /r/ and O /r/.

In order for the reader to be able to compare the eight K /s/ and eight L /s/ children, their personal characteristics are summarized in Table 12. The biggest difference in the two groups was that there are more third graders and no previous therapy in the K group. The mean IQ, reading percentile, and Token scores were not grossly different,however, the Detroit Memory for Syllables was much better for the K group. Figure 2 illustrates the K-L curves for the 16 /s/ children and L-O curves for the 16 /r/ children.

The summary of the two groups on ACTIVITY NAME, STIMULUS, CONTENT, and POSITION for the three time periods during the school year are presented in Table 13. The numbers represent the frequency of occurrence of all categories for every child during the specified time period. These values were summed horizontally for the total within each cell. Percentage values were then computed which total 100% in each case except for the CONSEQUATION cell. For this, a percentage was determined by tallying all occurrences of reinforcement (or token cost) and dividing by the total number of activities counted for that time period.

What are the main differences between the K and L learner? It appears from these limited descriptive data that the clinicians utilized similar teaching strategies (lesson plan), but that the L children took longer to learn the response. In other words, the response capability of the child seemed to determine the progression of stimuli which could be presented through the school year. There does not appear to be a qualitative difference in the teaching arrangements (ACTIVITY NAME, STIMULUS, CONTENT, POSITION), but rather, one of a temporal difference. That is when the child was able to produce one level of response the clinician then moved to the next level of stimuli presentation in some systematic progression. This is most clearly seen through the year by increased spontaneous speech (FC, SS, Bdg) and decreased drill activity (SD, GD) under ACTIVITY NAME. There were fewer auditory and more picture, plus child generated STIMULI. Under CONTENT there was a progressive use of Isolation, Syllable, Word, Phrase/Sentence and a predominant shift from the Initial to Mixed with little use of the Medial or Final POSITION.

There is one interesting difference to be observed between the K-L /s/ groups. K makes 56% GAIN during the first six weeks of therapy. In checking lesson plans the L children can now make the sound in isolation by the end of six weeks. Why don't they, like the K group, make a similar 56% GAIN during the next 12 weeks which is twice as long as the K children's first six week period? Instead, the L group makes only a 31% GAIN.

By inspecting the lesson plan data (and the Tone Keyboard data to be described later) it is evident that two things occurred: (1) During the

EU2-3 period, the L children received more auditory stimuli than the K group during the first six weeks, and (2) the L learners had more practice at the initial position of words and less practice with words in the mixed position. It has been the observation of the first author that clinicians tend to provide too many auditory models for child imitation when they should permit the child to self-generate more responses via picture or graphic (written) materials. The other point which will be discussed in more detail later is that there seems to be greater learning when the target phoneme is imbedded in the mixed position in words and phrases.

3. Comparison of L /r/ and O /r/ on Lesson Plan Data

The nine L /r/ and seven O /r/ children personal characteristics are summarized in Table 14. There were no striking differences between the two groups on any of the measures. In fact, the O group has more third graders and no previous therapy which our earlier data analyses indicated was an advantage. See Figure 2 for a comparison of their curves. The summary of the two groups on ACTIVITY NAME, STIMULUS, CONSEQUATION, CONTENT, and POSITION for the three time periods during the school year are presented in Table 15.

The big differences in lesson plan intentions between the /r/ L and O learners was seen in the first six weeks of therapy. The L children had 54% of their ACTIVITIES in Standard or Game Drill compared to 39% for the O group. 56% of the stimulus was auditory (M + MP) for the L, but only 48% for the O group. The L children received under CONTENT 57% of their stimulation in Isolation or Syllable, but the O /r/ children had a 26% Isolation-Syllable stimulus. Note that for the L group, Initial position was 64% compared to 47% for the O group. Also observe that only 22% of the stimulus came in the Mixed position for the L, but 47% of the time the O children were presented with the stimulus in the Mixed position.

These descriptive data provide evidence that the /r/ O children were not receiving the same qualitative teaching arrangement (ACTIVITY NAME, STIMULUS, CONTENT, POSITION) as the L children. The causal question: Was this the reason for their not learning? The presumptive answer is yes. Contrary to the /s/ K-L comparison, where the teaching arrangements were similar for the two groups, in the /r/ L-O comparison, the program teaching arrangements (cognitive lesson plan) were not alike. Where L /s/ children may not have learned because of intrinsic (child) reasons, the O /r/ children may not have learned because of intrinsic and/or different teaching arrangements. And of course, both groups may not have learned for other X, Y, Z reasons not considered above.

4. Comparison of L /s/ and L /r/ on Lesson Plans.

We have discussed /s/ K-L and /r/ L-O learning curves, now let's look at the same learning curve (L) with two different phonemes, /s/ and /r/ (Tables 13, 15).

There is considerable qualitative similarity between lesson plan intentions for the /s/ and /r/ L curve learning patterns. The greatest difference appears to be that /s/ children had more auditory stimulation (especially in the first 18 weeks of therapy). The /r/ children got more stimulus presentations in the word/phrase categories. They also received more practice in the medial, final, and blend positions. However, both the /r/ and /s/ L curves had far more initial and mixed stimuli than medial or final, indicating that once the target phoneme was produced in the initial position, these clinicians generally emphasized imbedding the phoneme in the mixed position in words and phrases.

5. Summary of Time, Sessions, and Activities for K L O Learning Curves.

Each clinician noted on the lesson plan the time to the nearest minute spent in therapy. Total time does not include the probe tasks (SPT took three to five minutes and Talk was three minutes) which came every two weeks. Total activities also does not include the SPT OR THREE MINUTE TALK. A summary of these data for the four groups of learners for the school year is in Table 16. It is clear that the K /s/ learners had the least amount of therapy time (6.9 hours) followed by L /s/-/r/ (9-10 hours), and O /r/ had the most time with 12 hours. The most striking observation is that all children were scheduled for twice a week therapy, 20-30 minutes in length, and they should have received in 30 weeks (most schools have a 36 week year) anywhere from 20-30 hours of therapy. Clearly, there is considerable discrepancy in these hours and the children who were in therapy all year. Our records show that in the /s/ K groups all eight children were in therapy less than 30 weeks (range 12-29, x = 22), six of the eight /s/ L were less than 30 weeks, three of the nine /r/ L were less than 30 weeks, and all seven /r/ O children were in therapy for 30 weeks. All children started therapy after October 1, 1972, and none went beyond May 30, 1973 (approximately 31 weeks, minus the week for Christmas equals 30). Screening and scheduling were done in September.

But let's look more closely. The K /s/ group had an average of 24 sessions and a mean of 22 therapy weeks for the year. For the O /r/ group, all children were seen for the entire year (30 weeks) with an average of 40 sessions which amounts to 1.3 sessions per week. This means that there was no real temporal difference in the amount of therapy impact received by the fast or slow learners, both were actually seen in therapy slightly more than once a week. Dublinske and Bruntzel (1974) reported in a work study of 143 clinicians in the state of Kansas, that two-thirds of their time was spent in remediation (therapy) which did not include diagnostic evaluations, consultations, or screening. The difference in real time spent in therapy reported by our clinicians is quite different from the expected projected time. It indicates that holidays, school events, sickness, transfer from class to speech office, and "getting ready" for therapy all take their toll from real therapy time.

The average session length was 17-18 minutes for all children and an ACTIVITY averaged seven to eight minutes. These clinicians utilized an average of two to three activities for each therapy session. No real differences were apparent across the groups.

From another point of view, speech therapy time with the K and L children was surprisingly brief. The hours reported here were for group therapy and therefore reflect the total time the child was in therapy. Some individual therapy programs boast correction in three to six hours. These K /s/ children did almost as well in group therapy. We continued to be impressed with the observation that public school therapy was relatively efficient in getting many children to criterion (high percent correct in conversation), but clinicians fail to dismiss the children from therapy after reaching criterion.

In a survey of 15 school clinicians which asked them to estimate the average length of time in hours it took to teach a child to be 85-90% correct in ten minutes of conversation, the following average times were obtained (the range is in parenthesis):

Frontal Lisp	38 hrs.	(8-195)
Lateral Lisp	55 hrs.	(7-200)
Consonant /r/	38 hrs.	(5-130)
Vowel /r/	53 hrs.	(5-210)

The clinicians of course qualified their estimates by such statements as "it all depends upon the child", etc. Nevertheless, their estimates suggested that they believe that the average /s/ or /r/ child takes at least a full year of therapy. These clinicians also reflect the prevalent notion that frontal lisp is easier to correct than lateral lisp and consonantal /r/ easier than vowel /r/.

6. Summary Discussion of Lesson Plan Materials:

The high use of the mixed position category observed with L /r/ and /s/ was also found in the K /s/ group. Could it be that since both K and L children were successful, that this observation should be carefully considered by clinicians in their programming? That is, once the sound is successfully produced in the initial position, then to achieve the best (speed and stability) generalization, the clinician should arrange target phoneme practice materials in a variety (mixed) of positions at the word and phrase/sentence level of complexity.

The literature is supportive, but not entirely clear (or conclusive) on this point. McLean (1970) found that institutionalized retarded subjects did not generalize the trained phoneme to a word position different from that in which it was trained. One study (Powell and McReynolds, 1969) evaluated the generalization of IMF position training with /s/ and another (Elbert and McReynolds, 1975) evaluated the training of four /r/ allophones. Both studies concluded that normal elementary school children will begin to emit the sound in positions other than the trained context.

Raymore and McLean (1972) trained four institutionalized subjects in the initial, final, and medial positions and in a randomized presentation of all three positions. The level of responding was higher and more stabilized with the randomized treatment. Finally, McLean and Raymore (1972) observed that training to 100% criterion at the word level in nine normal elementary school children did not necessarily result in generalization of correct responses to sentences and conversation. Training in words, sentences, and conversation appeared to be necessary for some children. Across-position generalization and generalization to untrained words occurred for some subjects. Also, when a five week vacation was instituted, regardless of the program phase, subjects made gains in correct phoneme production.

McReynolds (1972) found no generalization after isolated /s/ training, but the children did learn from initial and final syllable drill. Gains from medial syllable /asa/ practice were difficult to interpret because "it may not have functioned as a new articulatory response to be learned". She concluded that generalization was more apt to occur when the correct sound was trained in the context of other phonemes and by changing the position of the phoneme.

Ruscello (1975) trained six elementary school subjects who were not initially stimulable on /s/ in isolation. He began training in isolation, then in words using the McLean (1970) stimulus-shift paradigm. Some children did generalize to formerly misarticulated words after training in isolation alone. He also found that children who had training in initial, final, medial positions had more words correct on test probes than those trained only in the initial position.

McLean's stimulus-shift program used with normals (McLean and Raymore, 1972) takes the child who is stimulable on the target sound and begins training at the word level (imitation of the clinician with the sound in the initial position). This procedure is different from Gerber (1973) who recommends that the target phoneme be practiced in nonsense syllables and nonsense words until skill is obtained before moving to real words. Winitz (1975) recommends training the target sound in nonce (nonce words, than nonce words in conversational speech, transfer nonce words to English words, then phrases, sentences, and conversational speech).

From the above studies we can conclude the following:

(1) Some children generalize from isolation drill to words; others need to have practice in nonce syllables and then words.

(2) It appears more likely that a child will have greater generalization to words which contain the target phoneme in sentences/conversation, if he has had previous training in different positions (I, M, F) or allophones.

(3) Some children generalize from word drill to conversation; others need practice in phrases and sentences before conversational drill.

The only way to determine how well the child is performing at different levels is to systematically probe his productions under a series of specified conditions (McReynolds, 1972; Elbert and McReynolds, 1975). The early work of Wright, Shelton, and Arndt (1969) empirically demonstrated that specific probe measures during speech therapy provided information about the transfer of the target phoneme in imitation (SPT), reading, and spontaneous speech. The SPT and Talk probes used in this study provided the clinician with bi-weekly feedback about the progress of each child throughout the school year. The SPT evaluated imitative skill at the isolation, syllable, word, or phrase level and the Talk task helped the clinician to determine how well the child was performing in spontaneous conversation. As one develops skill in listening to conversation, different allophones or contexts can be distinguished in connected speech. The clinician can then tailor the stimulus presentations to the individual needs of the child.

The K-L curves represent children who were successful in acquiring their target sound in conversation. From studying their lesson plans these clinicians planned to utilize isolation, syllable, word, phrase/sentence, and conversation in their therapy. Most training seemed to begin at the isolation level, then shifted to the initial syllable or word position, then the mixed position (I, M, F), and finally phrase/sentence drill. Little use seemed to be made of the medial and final positions as specific practice steps. The high occurrence of the mixed positions and the considerable practice in connected (FC, SS, Rdg) speech suggest that these procedures were used for carryover (transfer-generalization*) of the target sound into conversation. We stress "suggest" because we do not know exactly what each child actually received in therapy. The lesson plan, as noted earlier,

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*Griffiths and Craighead (1972) reserved the term carry-over for the measure of generalization that occurs from training in therapy to spontaneous speech. Mowrer (1971) defined carryover "as used by clinicians generally refers to the transfer of correct articulation in speaking situations outside the clinical setting".

represented the clinicians' intentions, but does not necessarily describe the therapy interactions. In spite of this admonition, we would wager that most children who are successful in carryover generally will need production practice of the target phoneme in the mixed position in conversation. As we have indicated elsewhere (Section IV), once the child can produce the sound correctly at better than 75% in conversation for two consecutive probes one week apart, he can be dismissed from therapy with better than an 80% chance of not having a remission.

Sommers and Kane (1974) summarized thoroughly the major (and minor) articulation therapy models and procedures used in this country over the past 50 years. They reported varying degrees of emphasis on carryover training at the conversation level by the different authors. It is difficult to evaluate therapy procedures as written by different authors or carried out in practice by clinicians, but it appears to me (WMD) that, especially in the past 5-10 years, there has been an increase in the practiced use of conversation in therapy. Gerber (1974) reviewed nine articulation programs which have emerged in the past 10 years and five of them utilized conversation as a test probe. This is quite different from the more traditional pre-post testing done on a standard articulation test (the Templin-Darley or McDonald for example). The lesson plan data reported here tend to confirm the notion that clinicians specify free conversation (13% of the therapy activities) second only to standard drills (20%) as a category of therapy. It appears that workers in the vineyard (as Van Riper likes to say) are providing practice of the target phoneme where the terminal objective should be -- in conversation.

What has caused this apparent shift in therapy emphasis (if indeed there is one)? Two forces have been active in the past 15 years. First, psycholinguistics has made quite an impact in our field with its attention placed on the study of the phoneme in context, morphology, and syntax. Notions of coarticulation and distinctive features are common now. Evaluation of the phoneme in complex linguistic units made the study of connected speech in conversation a natural step. Second, accountability and perhaps even more so, relevancy, has played an important part in our thinking in recent years. This has forced us to seek more precise measures of competency of the target phoneme in conversation.

F. Interaction Analysis of Therapy with Tone Keyboard (TKB).

As outlined in the Methodology section, we worked hard to obtain on-going information about the actual interaction between the clinician and child during therapy, but much of our efforts were futile. The Tone Keyboard was utilized and the clinicians sent weekly tapes to the project office to be decoded at the computation center. Even though we believed that most of the bugs were worked out in our pilot year III, many - to our frustration - still remained. There were many human errors on the part of the clinicians in providing accurate I.D. information in certain TKB entries; this resulted in misinformation when the tape was decoded and a large loss of valuable data. We also had calibration problems in converting the tones to computer tape for print-outs. Finally, available time and funds also constrained our abilities. Consequently, the available data to us via the TKB was greatly reduced.

After the KLMO curve types had been identified for the Year IV children, we went back to the TKB data pool and located reliable tapes for 13 different children and three clinicians amounting to approximately 51 hours of therapy throughout the school year (Table 17). There were four K (2 /s/, 2 /r/), six L (1 /s/, 5 /r/), and three M (3 /r/) curves represented.

1. Total Antecedent, Child Response, and Subsequent Events.

The events which occur during speech therapy can be defined in different ways (Diedrich, 1969; Johnson, 1969; Prescott, 1970; Boone and Prescott, 1971; Lingwall and Engmann, 1971; Schubert, 1974). Table 18 summarizes all the clinician and child events by learning curve KLM and time period EU1-2 (first six weeks), EU2-3 (next six weeks) and EU3-4 (final 12 weeks) during the school year. Under clinician antecedent event are listed two categories: talking (AG, F, V) and providing auditory models for the child to imitate. When the clinician said to the child "Say the sound or word again" the Again (AG) button was pushed. Directions given to the child about movement or placement of his articulators was recorded as Feedback (F). All other talking by the clinician was indicated by the Verbalization (V) button. Under auditory model was included Isolation, Syllable, Word, or Phrase/Sentence. No provision was made to describe visual stimuli on the Tone Keyboard. Boone and Stech (1970) observed that 80%-95% of the therapy process occurred at the verbal level; therefore, we believed that the auditory stimuli were the most important to describe. We do have data on Picture and Graphic stimuli reported on the clinician's lesson plans (Section E).

Under Child Response two broad categories were summed. The first included any verbalization (V) by the child not specifically related to the clinician's stimuli, auditory discrimination (DM) responses, and when the child made a response which was recognized as an error and self-corrected (Z). The second category included all correct (+), approximations (/), and wrong (-) target phoneme responses.

Finally, under clinician subsequent events (SE) are included all consequation by the clinician for a child's response. For correct responses the clinician might have paid off in tokens, nonverbal (smiles, head nods, etc.), or verbal (good, ok, yes, correct). For approximations (/), the statements

"that's better" or "it's closer" might have been used. Punishment (-) was usually verbal (that's wrong, no), but also included negative head nods, or token cost (removal of a chip, etc.).

The length of time for each event is not recorded, only when the event started. How can we determine an estimate of the amount of time spent under clinician auditory stimulus, child response, and clinician consequation? Fortunately for us, Prescott (1970) asked that question and found a high relationship between the timed duration of events and the number of events described during speech therapy (r = .92). By summing the number of events for each category we can obtain an estimate of the amount of time spent for each group of learners.

The Lingwall and Engmann (1971) study evaluated 10,487 events (five clinicians and eight clients) from videotapes and found clinician antecedent events (visual and auditory) occurred 43% of the time, child response events 39%, and clinician subsequent events 18%. For 7,107 events (five clinicians and 36 clients) studied from audiotape, they found antecedent events (auditory alone) 42%, child response events 34%, and clinician subsequent events 24%.

In our study we obtained a grand total of 21,637 events from the Tone Keyboard and found the following interactions; antecedent events 15%, child response events 66%, and clinician subsequent events 19% (Table 18). These distributions of therapy effort were quite different from those reported by Lingwall and Engmann (1971), especially in the clinician antecedent and child response categories (Fig. 3). The reason for these differences may be due to the fact that in the TKB data no O curve or other types of inconsistent learning patterns were represented. The KLM children all learned the target phoneme which may account for the more frequent child responses reported on the TKB compared to the Lingwall-Engmann data. Other differences such as the length of each session studies, period of time in the year, etc., may also influence child output as well as antecedent events.

The data in Table 18 also provides a breakdown for our KLM learners and three time periods. It can be noted that the K group had the fewest AE's (14%) compared to the L (27%) and M (30%) for the first six weeks (EU1-2) of therapy. The K's also had far more child responses (71%) than the L (45%) and M (43%). Finally, clinician consequation (SE) was far fewer (15%) for K than L (28%) and M (27%).

During the next 12 weeks (EU2-3) the K group received very few auditory models (1%) while L had 6% and M 4%. The number of child responses have increased for L (62%) and M (55%). M also has increased discrimination (DM). K's increased in SE while L-M stayed about the same.

In the last 12 weeks of school (EU3-4) the KLM groups got little or no auditory stimulation and little change was noted in the Again, Feedback, and Verbalization category. All groups have increased child response: K is now at 89%, L at 72% and M at 80%. Frequency of clinician consequation diminished; in some cases less than half as often as in the previous time periods.

This analysis revealed that these clinicians spent most of their time in presenting auditory models during the first six week of therapy and then very little after that. This supports the K-L lesson plan data reported in Tables 13 and 15 (Section E) which found high auditory model in first six weeks and then large increases in picture and graphic (written) materials in the next 24 weeks. The other striking finding was the large amount of time consumed by child responses, especially for K in the first six weeks. L and M had far fewer. Since M had a 60% correct or better conversation level at baseline, it was surprising that these children were not responding at least as often as the K learners. The M group had many more clinician AE, too. The last major observation was that the K learners had little overt consequation especially in those first six weeks when they made their maximum gain. Additional comment will be made about this point in the next section when reinforcement ratios are discussed.

2. Category Analysis of AE, CR, SE.

Table 19 has more reduction of the total events distribution. In this analysis each category AE or CR or SE represents 100% of the events. Our interest is in determining the percent occurrence of each variable under each category.

(a) Clinician AE - AG, F, V. It can be observed that clinicians spend most of the auditory AE time in talking (verbalization is about 40-50 percent); however, saying "again" contributed a large portion of the clinicians' AE repertoire, especially during the first six weeks (EU1-2).

(b) Clinician AE - Auditory Models (I, S, W, Ph). The most obvious is the diminished use of isolation and syllable models during the first six weeks (EU1-2) which are replaced by word and phrase at EU2-3 and EU3-4 during the last 24 weeks. Of note here is that the K learners received 85% of their auditory models at the word level during the first six weeks of therapy.

(c) Child Response - V, DM, Z. The percent occurrence of verbalization, discrimination, and self-correction is trivial in light of the high occurrence of target phoneme responses. These children spent very little time "just talking". These therapy samples appear very goal oriented.

(d) Child Response - Correct (+), Approximation (/), and Wrong (-). Except for the M group during the first six weeks (EU1-2) which is at 55% correct, all the other percent correct tallies were at the 80-98% level. These clinicians perceived few approximation responses. We anticipated many more especially during the early weeks of therapy. The M group had more than the K-L children which was probably a reflection of one aspect of their problem, i.e., they still had trouble in making on-target responses, and they may be inconsistent in their responses, too.

(e) Clinician SE - Correct (+), Approximation (/), and Wrong (-). By far the greatest proportion of clinician consequation was for correct responses. Note that the M learners had the most punishment (-) events, 24% at EU1-2 and 37% at EU3-4.

(f) Reinforcement and Punishment Ratios. (C+/K+ and C-/K-). The clinicians for the K learners provided only a 20% positive reinforcement ratio during the first six weeks, while L and M had 62% and 69%. During EU2-3, the K group got increased positive reinforcement, but the L and M dropped almost in half. And for the final 12 weeks, all groups greatly decreased their positive reinforcement ratio. The punishment ratio was quite different for the KLM groups, and across the three time periods. Except for M at EU1-2, all groups had a higher punishment ratio than a positive reinforcement ratio. The clinicians more often provided feedback when the child's target phoneme response was wrong.

(g) Discussion: An important observation is the clinician stimulus presentations. Here we note that clinicians of K learners provided fewer auditory stimuli than was given to the other two groups. M children had a few isolation drills, but lots of syllable drills, even more than the L children. Observe also that the K learners had more auditory stimuli presentations consisting of words and phrase/sentences. The M children (who have the target phonemes at 60% or better in conversation) were not getting much auditory stimulation at the word/phrase level. They may have received more visual (pictures, printed words, and sentences) stimuli than the other two groups.

We might infer that K learners needed less auditory stimuli because they could self-generate or initiate the target phoneme independent from clinician modeling. On the other hand the observation poses the interesting question: Were children who were given fewer auditory models helped to learn faster because they were forced early (or oftener) to self-generate their own production? It has been the first author's observation that beginning clinicians frequently provide too much auditory imitation behavior and do not give the child opportunities to produce the sound on his own initiative and effort. The above findings on K children coupled with the clinical supervisor's observation should be tested empirically.

The number of times that the clinician said "Again (Ag)" meaning "Say the sound or word again", was similar for all three groups. The number of times feedback (F) was provided to the child was also the same for all three learning groups. By feedback is meant the clinician told the child something specific about his articulators, e.g., "Keep your tongue behind the teeth". We had originally thought that perhaps the good clinician was one who gave a lot of feedback to the child. Mowrer (1973) and Grandstaff (1974) had made similar observations. Since we do not have TKB data on O learners, this idea may still be true, but it did not differentiate the K, L, M groups.

Discrimination (DM) was not utilized often. For these K learners discrimination was not used and occurred infrequently for the L and most for M. Discrimination was never entered on the daily lesson plans of these four K learners either. Remember from our data analysis for the entire year discrimination activities made up only 2.8 percent of the daily lesson plan activity.

Ear training has a long history in the field (Van Riper, 1939) and

automated auditory discrimination programs have been suggested by Holland and Matthews (1963). Garrett's (1973) data supported the notion that if a child were stimulable there was little reason to practice discrimination training. The sample of clinicians reviewed here demonstrated little practice in discrimination training.

Child self-correction (Z) occurred very infrequently for K, L, and M learners. We thought this behavior might be observed with higher frequency among the fast (K) learners. Not true. Reports in the literature (McReynolds, 1972; Gerber, 1973; and others) have also stressed the value of self-monitoring and we believed that self-correction might be an indice for that behavior. As you can see self-correction occurred only during the first six weeks of therapy for M children.

Productions of the target phoneme by the child which were not wrong or not correct and consequated by the clinician with "that's better" or "closer" were labeled approximations. Some persons (Winitz, 1975, p. 74) believe that the clinician should reinforce only correct responses. Reinforcement of partially correct responses may result in slowing down the acquisition of correct responses. Grandstaff (1974) reported no significant differences for approximation responses (he called them "gradient responses") among untrained, moderately trained, and trained clinicians.

Our data reported here would suggest that in the judgment of these clinicians approximation responses either occurred very seldom in the output of the child or were considered wrong. It's interesting to note that the M children, those mastering the target phoneme at a slower acceleration than K or L, also have the most approximation responses. But in none of the three groups does approximation responses surpass wrong responses. The clinician consequation for approximation occurred more often that the child production of approximation responses. How come? The clinician may have given some approximation consequation for correct responses. These tallies were not done on a point for point basis, it's difficult to say when or why this occurred. Sometimes the wrong key on the Tone Keyboard was punched, the clinician meant to hit + and would hit - or the / button.

When all of the child's responses were counted, the correct one averaged 85% for all children. Maintaining a high level of correct response rate may be influenced by several factors:

(a) The clinician cannot take failure, i.e., she likes to feel good.
(b) The clinician believes the children cannot take failure.
(c) The clinician programs well, i.e., ala the Skinner errorless learning paradigm.

It is unclear why the M children had only 55% correct in the first six weeks. They received lots of syllable drill which apparently were perceived by the clinician as an error. Perhaps the clinicians adapted to the production of the phoneme (five out of the six were /r/ children).

Stech (1969) reported correct response ratios in the 60-90% range. He pointed out that correct response ratios are a function of the client's problem. Severe stutterers or voice problems might result in almost 100% incorrect responses, but mild language or articulation disorders could result in almost 100% correct responses. Mowrer (1969) reported that an error rate

greater than 25% was detrimental to acquisition of new articulation responses. Grandstaff (1974) found that a 70-90% correct response ratio was maintained with the untrained clinicians at the lower level and the trained clinicians at the upper level

Boone (1970, p. 74-75) has stated "that the most effective speech therapy always starts where the client is and assures in every therapy session a high rate of correct response." K, L, M learners in our study were all successful and they all got stimuli which produced 80-89% correct responses. Unfortunately we do not have any O (poor learners) Tone Keyboard data to compare and see if they had low percent correct response rates. Boone (p. 75) goes on to say: "It appears to me that the best therapy has 75-80% successful responses. If it's higher than that, then what we are doing is probably not difficult enough". We (WMD) intuitively agree with Boone, but the data (Table 19) suggests that K learners did very well with 92-98% total correct responses.

K children who learned faster were not given as much positive reinforcement (C+/K+) as the slower L and M articulation learners. One presumption is that fast learners know they are doing well and therefore the clinician intuitively provides less overt positive reinforcement. Or perhaps the clinician knows that an irregular reinforcement schedule is better now. However, when the fast learner (K curve) made an error, the clinician gave punishment much more often.

Stech (1969) reported positive reinforcement ratio values in the 60-95% range with a mean of 80% for most clinicians. He went on to say that "high rates of reinforcement were associated with outgoing and experienced clinicians." The values reported in our data are far below Stech's, but are more in line with those reported by Strong (1971) who analyzed three undergraduate senior clinicians each with 30 minutes of therapy with articulation clients. She found an average positive reinforcement of 45% (34%-53%) and incorrect responses corrected by the clinician 63% of the time (48% to 86%). This is in contrast to most of the Prescott (1970) data which reported higher positive reinforcement than negative (punishment) reinforcement ratios for 10 out of 12 students studied.

In a more extensive study, Lingwall and Engmann (1971) evaluated 2,481 subsequent events with five clinicians and eight clients for 310 minutes of therapy from videotape. They found positive reinforcement occurred 43%, punishment 20%, no subsequent event 17%, and the remaining was other events. From 2,590 events audio tape recorded on five clinicians and 36 clients for 256 minutes, they found positive reinforcement 53%, punishment 7%, no subsequent event 32%, and the remaining other or irrelevant events. Our positive reinforcement rate was generally lower and our punishment ratio was much higher than Lingwall and Engmann reported. The Tone Keyboard may have had the effect of alerting the clinician to indicate a punishment consequation.

Although our clinicians were instructed to punch the key which indicated positive reinforcement whenever they said "good", gave a token, provided an affirmative headnod or smiled, perhaps they failed to do so. Even if this did happen, it fails to account for the differential rate of positive consequation found in the K L M groups.

Ingmire and Schuckers (1975) reported on the category and frequency of verbal reinforcement utilized by clinicians in schools. They cited evidence from psychological literature that there are two types of verbal reinforcement; person oriented reinforcers (good, fine, ok, great) which connotes praise or approval-disapproval, and performance reinforcers (right, wrong, correct) which relate to response accuracy. The authors stated that performance reinforcers demand a binary decision and person reinforcers operate on a subjective continuum of the clinician. We can go along with the two types of reinforcers, but disagree on the words chosen to be associated with both types. For example, "right" appears no less a person oriented word than a performance one. The reverse is true for the word "good". It appears to us that the words themselves are not the critical issue, but the specific context in which the word is said is crucial. In evaluating the responses of 11 school clinicians, Ingmire and Schuckers found that 91% were in the person (approval-disapproval) category (80% consisted of good, ok, and alright). Only 9% of the total reinforcers were in the performance category (right, yes, no).

Rosenham and Greenwalk (1965) cited by Ingmire and Schuckers believe that person reinforcers are more anxiety-reducing than performance reinforcers, i.e., they provide reassurance as compared to knowledge of results. Assuming this is true and assuming our clinicians also may have provided high person category reinforcement, then it's interesting to speculate that our clinicians somehow knew that fast learners (K) needed the least amount of reinforcement and L or M (the slow accelerators) needed the most.

Ingmire and Schuckers believe their data support the findings of Boone (1970) who reported that student clinicians were afraid to say no or to administer punishment. Data from Table 19 suggest a different interpretation. Clinicians provided stimuli for which children make a high percentage of correct responses which necessarily limits the number of wrong responses possible. Also, the clinicians on a percentage basis, more often gave punishment feedback than they did positive reinforcement. Apparently these clinicians were not afraid to say no. They also provided stimulus materials which enabled a high level of correct responding on the part of the child. In addition, we speculate that the clinician appears to be a sensitive barometer to the child's overall speech level and feelings as a learner in that situation because the clinician is more overtly supportive of the L-M learners and finds less "need" to give positive reinforcement to the fast learning K child. Remember, also, that there were higher EOI (better rapport) scores associated with K learners than for L, M, O. This provides additional indirect evidence that clinicians had a good relationship with K children and therefore did not need to "work-at-it" by providing high occurrence of positive reinforcement. Another obvious hypothesis is that these clinicians were good programmers and knew that once the sound could be made intermittent reinforcement was the best schedule.

3. Total Therapy Time and Clinician-Child Response Time.

Mowrer (1970, 1971) stressed that response accuracy and response frequency were two important factors for optimal learning in speech therapy. The total Tone Keyboard (TKB) time and clinician-child response times are listed in Table 20. The overall response frequency for all events which occur in the therapy process was 7.0 per minute as recorded on the TKB during one school year. The antecedent events occurred at 1.1 per minute, child response rates at 4.6 per minute, and subsequent events at 1.3 per minute. Ingmire and Schuckers (1975) found frequency of verbal reinforcement varied from 1½-9 times per minute with an average rate for 11 clinicians of four per

minute.

Of particular interest to us is that a differential response rate is evident acrossed groups of learners and time during the year. During the first six weeks (EU1-2) there's no doubt that the K learners had fewer clinician AE's, more child responses, and fewer SE's than the L-M groups. In the next 12 weeks the K learners had AE's which were still half of the L-M, but child response rates and SE were about the same.

In the first two time blocks (EU1 and EU2 = 18 weeks), the L-M groups have very similar response rates for AE, child response, and SE. During the last 12 weeks the M children had higher response rates (6.5) and fewer SE (0.6).

For 10 untrained, 10 moderately trained, and 10 clinicians with two years experience, Grandstaff (1974) counted 30, 36 and 36 total responses respectively. For a five minute therapy sample, extracted from a one hour individual articulation session, these clinicians averaged 6-7 responses per minute.

Mowrer (1969) cited Hurley (1969) who found a high of six responses to less than one per minute evoked by public school clinicians, with a mean of 2.79 for 10 therapy sessions studied. For three sessions on the S-Pack, Mowrer (1973) found over seven target /s/ responses per minute. He stated that initial response rates for isolation and words should be about 15-25 per minute down to 6-10 responses during connected speech. Lubert et al. (1971) reported that when a child can make up to 20 responses per minute he was dismissed from therapy. Garrett (1974) said that up to 600 responses per session (20 per minute) are obtainable in articulation therapy. Our group therapy data was supportive of Hurley, but contain far fewer responses than the others have suggested for individual therapy articulation programs.

We read (Mowrer, 1969, 1970) that clinicians should increase the child's correct response rate which presumably increases their rate of learning. The fact that children who learn faster can produce more responses per minute makes considerable clinical sense. When presented with a stimulus, fast learners usually make the response quickly and get ready for the next stimulus. The children who have trouble with imitation or self-production generally have a much slower response time to the stimulus. They work at it, often use sub-vocal rehearsal, and evidence start-stop response behavior, all of which increases the individual response time.

On the other hand, the findings of several workers have shown that increased response latency (between clinician stimulus and child response) may in fact improve acquisition. Locke (1971) cited the study by Romans and Milisen (1954) which found that adults imitative articulatory responses improved in quality as stimulus-response latency was increased from zero to nine seconds. He also cited Hutchinson (1969) who observed better responses in misarticulating children at 12 seconds than at zero, four, or eight second intervals. Dick (1975) had children delay their responses 0.400, 3.0, and 10.0 seconds following stimulus presentation. She demonstrated better production of /r/ in the initial position at the syllable level with the 10 second delay over training sessions. These children evidenced subvocal motor

rehearsal during the preresponse interval, but the other children were not observed to be subvocalizing. Garrett (1973, p. 110) found 2.8 seconds an optimal time frame for presentation of nonsense syllables to elementary school children. It may be important to delay while the child is first learning to make the correct response. After he becomes proficient, speech drills which increase the rate of responding then seem important for some children (Bankson and Byrne, 1972).

One commentary. If clinicians averaged one session per week for 20 weeks with K and up to 30 weeks for L and M groups (as reported in Section E.5), the total number of child responses for the year is approximately 1200 to 1800. For the rapid K learners, during the first six weeks, they made less than 500 responses. It seems extraordinary that a motor behavior such as speech, and more specifically a phoneme produced incorrectly, which may have had five years of practice for habituation (say age three to eight) and hundred of thousands of trials (8 /s/ per minute x 60 x 365 x 5 = 876,000) during the organisms most formative years (cortically speaking), can be modified to a correct response in spontaneous speech in less than 500 trials, with some three hours of formal practice, over a period of six weeks. Only the 30 year, two-pack-a-day smoker who quits the next day come to mind as one who can match or better this feat for adaptability of the organism.

As described in our methodology chapter the events were punched on the Tone Keyboard by the clinician and recorded on magnetic tape at a known speed. This permitted estimates for the number of times events occurred during the interaction between the clinician and the child. The computer printout summarized the percent of all the events for time periods from less than one second, for each second up to 10, and then anything above 10 seconds. Table 21 summarizes the mean and accumulated percent occurrence of events recorded by four clinicians. Clinician #42 was tallied with two K children, clinician #48 with two L and one M, and clinicians #25 and #41 were with unspecified children. The measure is one of duration (in seconds) between the starting time of any two successive events and the frequency of those events. It is not a measure of event duration. About half of the events occurred in less than a two second interval for three out of the four clinicians. From 70 to 81% of the events occurred in less than five seconds indicative of the swiftness of articulation therapy interaction. Less than 10% of the interactions had time intervals of more than 10 seconds between events. Joffe and Feldstein (1970, p. 22) noted that the "rhythmical unit in talking is a string of 2-10 words, averaging 5..." with a mean duration of approximately 1.64 seconds in natural dialogue. Hesitation and juncture pauses ranged from .66 to .77 seconds. Combining the duration of talking with the pauses amounts to less than three seconds. Their figures provide some external validity for the duration of events collected on the Tone Keyboard by our clinicians.

It is interesting to observe that clinician #42 with K children had 53% of the events in less than two seconds while clinician #48 with L-M children had only 35% in the same time period. Joffe and Feldstein suggested (p. 117) that personality differences may determine the temporal bursts of speech and pauses used by different individuals. Drash et al. (1970) observed response differences in a child who was presented with the same stimuli by four different clinicians. They noted that the clinician might be an important independent variable.

The complexity of the speech therapy task (discrimination, cognition,

and motor production) is one thing, the speed at which we process this information is another. It's a wonder that any learning occurs on the part of the child under such circumstances. Similarly, in the training institution we expect the student clinician to master all these intricate and rapid moves of the speech therapy game. It's no surprise that clinical training takes time.

In summary, these data must be viewed with caution because of the few children and clinicians represented; however, this descriptive study does suggest one hypothesis: Within limits, the child appears to determine the response rate and not the clinician. Remember, for the K and for four of the six L children, the clinicians were the same. Their clinical strategies and behaviors might not be expected to be that different with different children, yet the data presented indicated that there were considerable differences found on the K L M curves. The differences observed are believed to be child-bound, not clinician-bound.

IV. OTHER SUBANALYSES OF THE DATA

A. Conversation as a Measure of Articulation Learning

1. Three minute conversation samples were analyzed for 75 /s/, 64 /r/, and 65 normal elementary school children (1st thru 4th grade). No differences among the groups for spoken /r/ or /s/ words were found. Children with /r/ and /s/ errors have a significantly lower word output (60 wpm) than normals (90 wpm). /r/ words occurred about 16% of the time and /s/ words 11% of the time in conversation. The allophones of /r/ were as follows: Consonant /r/ occurs 39%, unstressed / ɚ / 51%, and stressed / ɝ / 10%. For /s/, initial position accounted for 29%, medial 22%, final 31%, and blends 18% of the time.

2. It was recommended that children with /r/ and /s/ errors should be terminated from therapy when their Talk scores (three minute conversation between child and clinician) reach 75% correct or better on two successive probes.

3. Follow-up Talk probes should be carried out eight and 16 weeks after dismissal to ensure that carryover has been maintained.

4. Between May and September less than 19% of the sampled children regressed below 75% correct in conversation, but an additional 12% (who were below 75% in May) were better than 75% correct four months later (September).

5. There was an enormous inefficiency of clinician time by maintaining children in speech therapy long after maximal gains had been reached. From 53-64% of the /r/ and /s/ children could be dismissed each year if a 75-85% correct in conversation criterion score were used (Table 22).

6. Clinician-child conversation samples collected in school may be representative of other adult-child speaking environments.

7. Phoneme generalization to conversation appeared to occur in therapy earlier than we have generally believed.

B. McDonald Screening Deep Test of Articulation

1. Project Year II Analyses of /s/ and /r/

To give the reader some idea about the severity of the /r/ and /s/ children as well as the type of other errors most frequently associated with primary /r/ and /s/ deficits an analysis of the McDonald Screening Deep Test of Articulation (1968) will be presented. These data come from Year II of our project which had the largest sample of children for any of the project years. There were 307 /s/ and 277 /r/ and these children would be representative of the majority of the children included in the project.

The clinicians from Project Year I had 88% mean agreement in determining which sounds were in error and 76% mean agreement on type of error (distortion, substitution, and/or omission). Our 23 clinicians in Project Year II had a range of 73-77% agreement on type of error produced in listening to taped samples prior to beginning their baseline testing in the field. Their percent agreement scores on determining which sounds were defective was not available, but was assumed as good as demonstrated by the Year I clinicians (i.e., in the 80's).

With the McDonald, nine phonemes are sampled ten times, so the poorest score a child could receive would be ten errors on any tested phoneme. At baseline the 277 /r/ children had a mean score of 7.79 /r/ errors (SD 2.16) and 307 /s/ children had a mean of 7.97 /s/ errors (SD 2.62). A t-test for independent groups was nonsignificant which indicates that the two phonemes were similar in severity as measured by the McDonald Test. There were 71 (23%) out of 307 /s/ children who also had /r/ errors. The average /r/ error was 4.11 (SD 3.13) items wrong which was about half the number of errors of the children who had a primary /r/ problem. There were 84 (30%) out of 277 /r/ children who also had /s/ errors. The average /s/ error was 3.43 (SD 3.02) items wrong which was also about half the number of errors of the children who had a primary /s/ disorder. In other words, the majority of primary /r/ and /s/ children did not have associated /r/ and /s/ defects; when they were present, the number of errors (severity) was much less. Another way of stating the infrequency of combined /s/ and /r/ errors is that only 11% of the 584 children had more than three errors on the /r/ and more than three errors on the /s/ (each sampled ten times) on the McDonald Test.

What about the other phonemes measured by the McDonald /l/, /θ/, /ʃ/, /tʃ/, /f/, /k/, /t/? Since very few of these /r/ and /s/ children had /f/, /k/, /t/ in error, these were disregarded. The remaining four phonemes were counted as defective if they had three or more of the ten items in error. Less than three errors were ignored and considered normal. This is a more stringent criterion than McDonald and McDonald (1974) who considered three errors within normal limits. Table 23 shows the distribution of /tʃ/, /θ/, /ʃ/, and /l/ errors for the 307 /s/ and 277 /r/ children. Chi square was used to test the association of errors with /s/ and /r/. The /tʃ/ and /ʃ/ errors occurred significantly more often in /s/ children, whereas /l/ occurred more often in the /r/ children. This finding was expected. The surprising observation was no difference in the proportion of /θ/ errors between the two groups. It was anticipated that the /s/ children would have significantly more.

From this analysis one gains some support for the notion of feature analysis. /s/ and /ʃ/ appear to have similar fricative features, whereas /θ/ also containing fricative does not appear to be any more associated with /s/ than /r/. On the other hand the affricative /tʃ/ is more associated with /s/ errors. /r/ and /l/ are considered to be glides to or from certain vowel positions and /ʒ/ and /L/ (vowelized l) are considered vowel continuants (Kantner and West, 1941). The /r/ and /l/ are called semi-vowels by Fairbanks (1960). By whatever classification the /r/ and /l/ appear to be more related in errors than /s/ and /l/.

2. Generalization of Training

Another question concerns how much generalization may occur with /r/ and /s/ training to the other phoneme errors, specifically the /tʃ/, /ʃ/, /θ/, and /l/. No strict control was maintained on the clinician as to whether they actually did work on these phonemes in addition to the primary /s/ or /r/ therapy. However, from our analysis of the data cards, most clinicians worked only on /s/ and /r/ for that school year. Furthermore, we are assuming random therapy effort on these other erred phonemes for both /r/ and /s/ groups. Table 24 indicates the number of children who did or did not improve on a given phoneme over the school year (September-May). The criteria used was an improvement of one or more erred items out of ten on the McDonald Test (e.g., ten errors at baseline to nine at post therapy or five errors to three, etc.). Chi Square analysis for all four phonemes (/tʃ/, /θ/, /ʃ/,

and /l/) was nonsignificant indicating that neither the /s/ or the /r/ treated children had better generalization to these other phonemes. Both groups demonstrated an improvement for all phonemes but no differential improvement was noted. Because of distinctive feature notions, it had been anticipated that /s/ training would have a greater effect on the /tʃ /, /θ/, and /ʃ / than /r/ training. But this did not occur. It might be hypothesized that the /ʃ /, /θ/, and /tʃ / are complex sound units (typically occur later developmentally) and that the acquisition of /s/ and /r/ is a complex motor process, too. Sander (1972), after reviewing the developmental norms, had indicated that /s/ and /r/ take a long time to stabilize in the child's expressive repertoire (from 3 to 6 years of age for /s/ and 3 to 8 years of age for /r/). Therefore, generalization of /s/ and /r/ training to other phonemes might not only be considered along distinctive feature units, but along a motor complexity continuum as well (McReynolds, 1975).

Type of sound (/s/or /r/) was not significantly different on baseline scores (EU1), previous therapy, grade, number in therapy group (NGP), and sessions per week (all have demonstrated an effect on GAIN); therefore, these variables would not influence any differences found between /s/ and /r/ on the questions of generalization of learning to associated errors, i.e., /tʃ /, /θ/, /ʃ /, and /l/. This should strengthen the argument that training on one sound does have generalization to other errors. Training may not be sound specific, but may reflect a more general factor of learning how to use complex motor units. This conclusion must be considered tentative because of the lack of therapy control noted above. Also, no control group was observed to determine if the same degree of improvement would have been noted without therapy.

We did have a group of no therapy parochial school children (N=47) with primary /r/ errors (mean grade 2.2 range 1-6 grade). Their distribution on associated errors on the /tʃ /, /θ/, /ʃ /, and /l/ using Chi Square analysis was similar to the children who received therapy (N=277). Next we looked at the improvement of their scores on these error sounds. There were no significant differences between the two groups. One basic problem with these data, of course, were the small numbers available in the no therapy group. However, if they can be supported with additional numbers then one would conclude that the no therapy /r/ group showed as much generalization for their associated errors as the treated group. This implies that both training and maturation (over a nine month period) appear to have an effect on the improvement of error sounds. What is surprising in all this is that the children who received therapy did not show greater improvement than the untreated group on their subset of errors. In contrast, we have shown that training on /s/ had marked generalization to /z/. The parochial school (untreated) children used for comparison also showed improvement on /z/, but not nearly to the extent of the treated group. One possible reason for not showing any differential improvement on the /tʃ /, /θ/, /ʃ /, and /l/ may be the grossness of the McDonald Test (albeit 10 items for each sound), contrasted to a 30 item SPT sample used for the /s-z/ study.

3. KLMO Learning Curves

The next reasonable question about the errors reported on the McDonald Test concerns the K L M O learning groups. Do K children have fewer associated errors than the O children? Table 25 summarizes the percent occurrence of errors in addition to the primary /s/ or /r/ error. Clearly, K learners

(/s/ or /r/) have fewer additional errors than the other three curves. M learners have fewer errors than L. O learners have more errors than all other curves. The presence of additional errors is similarly distributed across the learning curve patterns (KLMO) regardless of primary error type (/s/ and /r/). Also of interest is that when /s/ is described as frontal or lateral there is a systematic increase of lateral errors and decrease of frontal errors with learning curve type. K has far more frontal (80%) than lateral errors (20%), and O has about an equal distribution of each. This finding seems to argue for the fact that frontal errors are more frequently associated with faster learning children. However, we have demonstrated (in another analysis) no real difference in gain and gamma scores between children who demonstrated frontal and lateral /s/ errors.

V. SUMMARY

The global strategy of a five year project supported by the U.S. Office of Education was to identify effective teaching programs for elementary school children who had achieved correct articulation performance in spontaneous speech. Speech clinician and child characteristics, as well as their interaction behaviors, associated with the most effective learners were to be isolated.

The first phase was concerned with accountability, that is, teaching school speech clinicians to accurately assess the change in speech responses which children made over time. Clinicians were taught to count articulation responses from imitation (Sound Production Task) and during spontaneous conversation (a three minute Talk task between clinician and child). Learning curves of the speech progress were derived from these percent correct scores made every two weeks throughout the school year. Data was analyzed on 57 clinicians and 1108 children from grades one through six. Only children with /r/ or /s/ errors were analyzed. The average /r/ child had eight errors out of 10 items on the McDonald Screening Deep Test of Articulation. The average /s/ child had eight errors out of the 10 items.

Scores from SPT and Talk were combined to form a Unified Score (percent correct) throughout the school year for all three project years. Estimated Unified Scores were created by averaging Unified Scores (Table 1). Summary data were generated on four EU numbers: EU1 - Baseline, EU2 - after six weeks of therapy, EU3 - after 18 weeks of therapy, and EU4 - at the end of the school year after 30 weeks of therapy. Three other values were computed: GAIN (EU4-EU1); GAMMA (3+2-4-1) is a number which reflects the rate of learning (it is not a percent correct score); and LEVEL is an average of all four EU numbers (Figure 1).

Thus far we have been able to isolate four distinctive learning curves for 45% of the children. We have named the four learning curves KLMO; the letters KLMO refer to type of curve, not to phonetic error (Fig. 1).

K = High positive GAMMA (greater than 50).
L = High negative GAMMA (greater than minus 10 and GAIN greater than 50% correct).
M = A near zero GAMMA and LEVEL is greater than 75% correct.
O = A near zero GAMMA and LEVEL is less than 30% correct.

Independent variables studied included clinician characteristics (experience, age, degree, ASHA CC, self-concept, rapport), child characteristics (sound, sex, previous therapy, grade, I.Q., Reading, Token, Detroit, GFW, dental) and therapy arrangements (number of sessions/week, number in group).

The following summary identifies those factors which differentiated articulation learning.

A. Child Characteristics

1. /s/ children make more gain and learn faster than /r/ children.

2. /r/ and /s/ children were not significantly differentiated on Peabody Picture Vocabulary Test (PPVT), Goldman-Fristoe-Woodcock (GFW) Auditory Discrimination, Detroit (Auditory Attention Span for Related Syllables), Token Test (Part V), standard reading tests or diadochokinetic rate. /s/ children

did have significantly more tongue thrust and open bite.

3. Forty-five percent of the 1108 children were categorized into four basic learning curve patterns for the school year. Fast learners (K) were better than slow learners (O) on the PPVT, Detroit, Token, and Reading. This result holds for both /s/ and /r/ children.

4. Slow learners had more associated articulation errors than fast learners.

5. No sex difference was observed on KLMO learning curves.

6. GFW auditory discrimination, socio-economic, divorce, or minority made no difference on /s/ vs. /r/ on KLMO learning patterns.

7. Tongue thrust, open bite, diadochokinetic rate made no difference in KLMO learning curves.

8. Previous therapy, when considered by itself, had no effect on GAIN scores by the end of the year. Children with no previous therapy had faster learning curves (GAMMA) than children who had previous therapy.

B. Clinician Characteristics

1. Certificate of clinical competence, degree, and years of experience were not different on KLMO learning curves.

2. Older clinicians had more K children, younger clinicians had more O children.

3. High clinician rapport was more frequently seen with K children and low rapport with O children.

4. Good self-concept of the clinician was more often associated with K and poor concept with O learning curves.

C. Summary Statements Extracted from Lesson Plan Data based on 27 Clinicians, 212 Children, and over 19,000 Activities for the School Year.

1. Standard drill (20%) was by far the most frequently used activity in speech therapy followed by Free Conversation (13%). Discrimination and self-monitoring activities took up only 3% of the activities for the school year.

2. The most frequent STIMULUS category was Child Generated (20%), i.e., the child was expected to "make-up" words or sentences. Use of Pictures (24%), Graphic (21%), and Auditory Model (21%) came next.

3. Content included Isolation (5%), Syllable (6%), Words (33%) and Phrase/Sentences (54%).

4. Mixed Position (i.e., the target phoneme was used in the initial, medial, final, or blend position) occurred most frequently (70%). This was followed by Initial (18%), Final (7%), and Medial (3%).

5. The high occurrence of the mixed position and phrase/sentences (connected speech) suggest that these procedures were used to obtain carry-over (generalization) of the target sounds into conversation.

D. Summary Statements Extracted from Analysis of Lesson Plans Based on 17 Clinicians, 16 /s/ Children and 16 /r/ Children with KLO Learning Curves.

1. These clinicians appeared to use similar teaching strategies for K and L learners. When the child was capable of one level of response the clinician moved to the next level in systematic fashion. There was a pro-

gressive use of Isolation, Syllable, Word, Phrase/Sentence and a predominant shift from the Initial position to Mixed with little use of the Medial or Final as separate training categories.

2. L learners received much more auditory stimuli than the K learners in the first six weeks of therapy.

3. Different teaching strategies appeared to be used by the clinicians of L and O learners.

4. Considerable qualitative similarity was noted between /s/ and /r/ L curve learners. /s/ received more auditory stimulation and /r/ children had more word/phrase categories.

5. On a schedule of twice a week therapy for 20-30 minutes, the children were projected to receive in a 30 week school year approximately 20-30 hours of therapy. The difference in real time spent in therapy reported by the clinicians was quite different from the expected time. Many children who were in therapy all year had 12 hours or less of actual therapy contact. Clinicians and administrators need to be aware of this when estimating 'hours of therapy impact'.

6. The average session was 17-18 minutes in length and a given activity lasted seven to eight minutes. These clinicians used two or three activities for each session.

E. Summary Statements Extracted from the Tone Keyboard Data.

A total of 21,637 therapy events were recorded from three clinicians with 13 different children representing 51 hours of therapy over the school year.

1. Antecedent events accounted for 15%, child response 66%, and clinician subsequent events 19%. These distributions are different from those reported in the literature.

2. The overall response frequency for all events was 7.0 per minute; antecedent event 1.1, child response 4.6, and subsequent events 1.3 per minute.

3. The fast learners were provided with fewer auditory stimuli than slow learners. Discrimination activities were seldom used for fast or slow learners.

4. In the judgment of these clinicians, approximation responses (neither correct nor wrong) either occurred infrequently or were considered correct or wrong.

5. A high level of correct responding (average 85% for all 13 children) was maintained by these clinicians and is similar to that reported in the literature.

6. The positive reinforcement ratio used by these three clinicians was generally lower and the punishment ratio higher than previous reported.

7. From 70 to 81% of any adjacent events (clinician-child or child-clinician) occurred in less than five seconds. About half of all the adjacent events were less than two seconds apart which is indicative of the swiftness of articulation therapy interaction between clinician and child.

REFERENCES

Bankson, N.W. and M.C.Byrne. 1972. The effect of a timed correct sound production task on carryover. J. Speech Hearing Res. 15: 160-168.

Barrett, M.D. and J.W.Welsh. 1975. Predictive articulation screening. Language, Speech, Hearing Services in Schools. 6: 91-95.

Bingham, D., R. Van Hattum, M. Faulk, and E. Taussig. 1961. Program organization and management. In F. Darley (ed.) Public School Speech and Hearing Dis., Monograph Supplement #8. 33-49.

Boone, D.R. 1970. A close look at the clinical process. in J.L. Anderson (Ed.) A Conference on Supervision of Speech and Hearing Programs in the Schools. Speech and Hearing Center, Indiana Univ., Bloomington, Ind.

Boone, D.R. and T.E. Prescott. 1971. Speech and Hearing Therapy Scoring Manual. University of Denver. Bureau for Education of the Handicapped, Office of Education, Grant No. OEG-0-70-4758-607.

Datamyte, 1969. Electro/General Corporation, 128 North Jackson Ave., Hopkins, Minnesota 55343.

Dick. L. 1975. The effects of imposed preresponse time delay on the production of /r/ in the initial position at the syllable level. J. Kans. Speech Hear. Assoc., 15, 56-65.

Diedrich, W.M. 1969. Analysis of the clinical process. J. Kansas Speech Hearing Assoc. 10, 1-8.

Diedrich, W.M. 1971. Procedures for counting and charting a target phoneme. Language, Speech and Hearing Services in Schools. Asha. 5th booklet. 18-32.

Diedrich, W.M. and J. Bangert. 1972. A unified score for imitation and spontaneous speech. Asha. 14: 481.

Diedrich, W.M. 1972b. Counting and Charting Target Phonemes in Conversation. 16 mm color sound film. Audio Visual Center, University of Kansas, Lawrence, Ks. 66045.

Drash, P.W., L.R.Caldwell, and J.M.Leibowitz. 1970. Correct and incorrect response rates as basic dependent variables in the operant conditioning of speech in non-verbal subjects. Paychol. Aspects of Disability. 17: 16-23.

Dublinske, S. and M. Bruntzel. 1974. Determining perceived and real program activity time in the public schools. ASHA convention paper, unpublished.

Elbert, M., R.L.Shelton, and W.B.Arndt. 1967. A task for evaluation of articulation change: I. Development of methodology. J. Speech Hearing Res. 10: 281-289.

Elbert, M. and L.V.McReynolds, 1975. Transfer of /r/ across contexts. Journal Speech and Hearing Disorders, 40, 380-387.

Fairbanks, G. 1960. (Second Ed.) Voice and Articulation Drillbook. Harper and Bros., New York.

Garrett, E.R. 1973. Programmed articulation learning. In Wolfe, W.D. and D.J.Goulding (eds.) Articulation and Learning. Charles Thomas, Publ. Springfield, Ill.

Garrett, E. 1974. Personal Communication.

Gerber, A. 1973. Goal: Carryover. Temple University Press, Philadelphia.

Gerber, A. 1974. Personal communication.

Grandstaff, H.L. A comparison of clinical behaviors of untrained, moderately trained, and trained speech clinicians during articulation therapy. Ph.D. dissertation, University of Cincinnati, 1974.

Griffiths, H. and W.E.Craighead. 1972. Generalization in operant speech therapy for misarticulation. J. Speech Hear. Dis. 35, 485-495.

Holland, A.L. and J. Matthews. 1963. Application of teaching machine concepts to speech pathology and audiology. ASHA 5, 474-482.
Hurley, M. 1969. An analysis of children's verbal responses during speech therapy sessions. M.A. thesis, Arizona State University.
Hutchinson,B.O. 1969. A pilot study: The effect of selected latency intervals upon articulation therapy. Illinois Speech Hear. J. 2, 6-10.
Ingmire, S.M. and G.Schuckers. 1975. The category and frequency of verbal reinforcement utilized by clinicians in schools. Unpublished paper, University of Indiana.
Joffe, J. and S.Feldstein. 1970. Rhythms of Dialogue. Academic Press, New York.
Johnson,T.S. 1969. The development of a multidimensional scoring system for observing the clinical process in speech pathology. Ph.D. dissertation University of Kansas.
Kantner, C.E. and R. West. 1941. Phonetics. Harper and Bros. New York.
Kenney, D.A. 1975. A quasi-experimental approach to assessing treatment effects in the monequivalent control group design. Psych. Bulletin, 82: 345-361.
Kent, R.N., K.D.O'Leary, C. Diament, and A. Dietz. 1974. Expectation biases in observational evaluation of therapeutic change. J. Consult. Clinical Psychol. 42: 774-780.
Krasno, R.M. 1972. Teachers' attitudes: Their empirical relationship to rapport with students and survival in the profession. (Technical Report No. 28). Stanford Center for Research and Development in Teaching, Stanford University, Stanford, California.
Lingwall, J. and D.E.Engmann. 1971. Event model of the clinical process. ASHA Convention paper, University of Kansas.
Locke, J. 1971. The child's acquisition of phonetic behavior. Acta Symbol. 2, 28-32.
Lubbert, L., K. Johnson, C. Brenner, and A. Aldersen. 1971. Behavior Modification Program for Speech Aides. Ideas, P.O. Box 741, Tempe, Arizona 85281.
McDonald, E. 1964. Articulation Testing and Treatment; A sensory-motor approach. Stanwix House. Pittsburgh, Pa.
McDonald, E. 1968. A Screening Deep Test of Articulation. Stanwix House, 3020 Chartiers Avenue, Pittsburgh, Pa. 15204
McDonald, E.T. and J.M. McDonald. 1974. Norms for the Screening Deep Test of Articulation: Based on a longitudinal study of articulation development from beginning kindergarten to beginning third grade. Project #73024. Dept. of Special Education, Penn. State University, State College, Pa.
McDonald E. 1974. Personal communication.
McLean, J.E. 1970. Extending stimulus control of phoneme articulation by operant techniques. In F.L. Girardeau and J.E.Spradling (Eds.), A Functional Approach to Speech and Language. ASHA Monographs Number 14, Washington, D.C. American Speech & Hearing Assoc., 24-47.
McLean, J. and S. Raymore. 1972. Programmatic research on a systematic articulation therapy program. Carry-over of phoneme responses to untrained situations for normal-learning public school children. Report No. 6, Parsons Research Center Reports, Parsons, Kansas 67357.
McReynolds, L.V. 1972. Articulation generalization during articulation training. Lang. and Speech. 15, 149-155.
McReynolds, L. 1975. Personal communication.

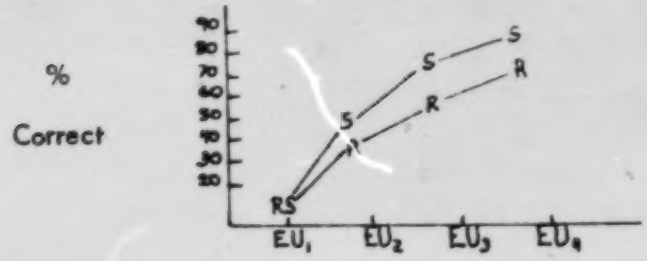
Mowrer, D.E. 1969. Evaluating speech therapy through precision recording. J. Speech Hear. Dis. 34, 239-244.
Mowrer, D.E. 1970. Measurement in speech therapy. Psychol. Aspects of Disability. 17: 24-28.
Mowrer, D.E. 1971. Transfer of training in articulation therapy. J. Speech Hear. Dis. 36, 427-446.
Mowrer, D.E. 1973. A behavioristic approach to modification of articulation. In W.D. Wolfe and D.J.Goulding (Eds.) Articulation Learning. Chas. Thomas, Springfield, Ill. 272 p.
Pendergast, K., S.E.Dickey, and A.L.Soder. 1969. A study of protrusional lisps to identify children requiring speech therapy. Final report. Project No. 5-0319. Contract No. OE-5-10-180. Office of Education, U.S. Dept. HEW. (Seattle Public Schools, 815 4th Ave., North, Seattle, Wash. 98109).
Powell, J. and L.V.McReynolds. 1969. A procedure for treating position generalization from articulation training. J. Speech Hear. Res. 12, 629-645.
Prescott, T.E. 1970. The development of a methodology for describing speech therapy. Ph.D. dissertation, University of Denver.
Raymore, S. and J.E.McLean. 1972. A clinical program for carry-over of articulation therapy with retarded children. Chapter 11 in J.E.McLean, D.E.Yoder, and R.L.Schiefelbusch (Eds.), Language Intervention with the Retarded. University Park Press, Baltimore.
Romans, E.F. and R.Milisen. 1954. Effects of latency between stimulation and response on reproduction of sounds. J. Speech Hear. Dis., Monograph Supplement No. 4, 71-78.
Ruscello, D.M. 1975. The importance of word position in articulation therapy. Language, Speech, and Hearing Services in Schools. Vol. 6, No. 4, 190-196.
Sander, E. 1972. When are speech sounds learned? J. Speech Hear. Dis. 37: 55-63.
Schubert, G.W. 1974. The Analysis of Behavior of Clinicians (ABC) System. University of North Dakota. Grand Forks, N.D.
Shelton, R.L., M. Elbert, and W.B.Arndt. 1967. A task for evaluation of articulation change: II. Comparison of task scores during baseline and lesson series testing. J. Speech Hearing Res. 10: 578-586.
Sommers, R.K. and A.R.Kane. 1974. Nature and Remediation of Functional Articulation Disorders. In Dickson, S. (Ed.) Communication Disorders: Remedial Principles and Practices. Scott, Foresman, & Co., Glenview, Ill. p. 520.
Stech, E.L. 1969. Quick analysis methods for continuous interaction scoring in speech therapy. Appendix A reprinted in Boone, D.R. and E.L.Stech. 1970. The development of clinical skills in speech pathology by audiotape and videotape self-confrontation. Final Report. Project No. 1381, Div. of Research, Bureau of Education for the Handicapped, U.S. Dept. Health, Education, and Welfare. Washington, D.C.
Strong, C. 1971. Analysis of verbal behavior in articulation therapy. In T.S.Johnson (Ed.) Clinical Interaction and Its Measurement. Dept. of Communicative Disorders, Utah State University.
Van Riper, C. 1939. Speech Correction Principles and Methods. First Edition. Prentice-Hall, New York.
Van Riper, C. 1963. Speech Correction: Principles and Methods. 4th Ed. Prentice Hall, Inc., Englewood Cliffs, New Jersey.
Van Riper, C. and R. Erickson. 1973. Predictive Screening Test of Articulation (manual, 3rd ed.). Continuing Education Office, Western Michigan University, Kalamazoo, Mich.

Winitz, H. 1975. From Syllable to Conversation. University Park Press. Baltimore.

Wright, V., R.L. Shelton, and W.B.Arndt. 1969. A task for evaluation of articulation change: III. Imitative task scores compared with scores for more spontaneous tasks. J. Speech Hearing Res. 12: 875-884.

Table 2.

PROGRESS OF 538 /s/ AND 570 /r/ KIDS



ONE-WAY ANOVA FOR EU-NUMBERS, GAIN, GAMMA, AND LEVEL FOR /s/ vs. /r/ KIDS

	/s/ Mean	/s/ Std.	/r/ Mean	/r/ Std.	F	p
EU_1	26	30	27	27	0.1	0.7
EU_2	50	28	40	29	34.7	<.001
EU_3	73	26	57	32	91.3	<.001
EU_4	84	21	70	30	80.7	<.001
GAIN	57	31	43	29	65.8	<.001
GAMMA	14	32	0	23	66.7	<.001
LEVEL	59	21	49	27	44.9	<.001

Means, standard deviations, and significance levels for 92 /s/ and 101 /r/ children in Year IV on several dependent and independent variables.

Variables		/s/ $\bar{X}$	/s/ S.D.	/r/ $\bar{X}$	/r/ S.D.	t	p
Dependent Variable							
EU_1 (Baseline)	%	27.9	33.4	35.1	29.7	1.59	n
EU_2 (6 wks.)	%	54.6	26.9	50.1	29.8	1.10	n
EU_3 (18 wks.)	Correct	81.1	20.9	70.9	27.8	2.87	<.01
EU_4 (30 wks.)	Correct	90.2	15.6	82.7	23.1	2.63	<.01
Gain	Correct	62.2	32.6	47.5	28.3	3.37	<.01
Therapy Arrangements							
Grade (1-4)		2.5	1.0	2.2	1.0	.93	n
No. Sess./wk.		Forced equal - all children had therapy 2 times/week					
No. in Group (2 or 3)		2.3	0.5	2.2	0.4	1.16	n
Daily Feelings		All 20 variables non-significant					
Prev. Therapy		non-significant					
Clinician Characteristics							
Age (23-49)		30.4	6.8	31.1	7.3	0.66	n
Years Experience (10-12)		5.2	3.3	5.1	3.4	0.15	n
EOI (rapport) (97-138)		120.8	7.2	122.2	7.7	1.29	n
Child Characteristics							
PPVT IQ (68-168)		102.6	15.4	102.4	13.8	0.08	n
GFW (percentile) (0-98)		26.5	24.0	25.5	21.4	0.30	n
Detroit (total score) (12-93)		49.5	15.9	47.1	16.1	1.02	n
Token (total score) (0-21)		15.8	3.1	15.5	2.8	0.68	n
Reading (percentile) (1-99)		53.5	29.2	49.2	30.4	1.02	n
Diadocho. (/a in 15")(19-84)		44.9	14.0	44.6	12.6	0.14	n
Dental Problem (6 items)		1.1	1.0	0.9	0.9	1.43	n
Tongue Thrust (11 items)		4.2	2.1	1.9	1.6	8.79	<.001
*Bite		1.8	0.4	2.0	0.2	3.78	<.001

*Means are calculated on 1 = yes, open bite; 2 = no open bite.

Table 3. Chi square analysis of KLMO on several child and clinician characteristics.

	K	L	M	O	p
Sound	5 x more /s/ than /r/			4 x more /r/ than /s/	<.001
Sex		Non-significant			0.4
Grade	too many 3rd	too many 1st	too many 4th too few 1st	O's in every grade	<.001
Prev. Ther.	73% No too few Yes		60% Yes too few No		<.001
Sess/wk.	too many 4 x/wk too few 1 x/wk			too many 1 x/wk too few 2 x/wk	<.001
No. in Grp.		too few 4	too few 3		<.002
Degree		too many MA too few BA	too many BA too few MA		<.001
ASHA	too many CC			too many pending *	<.001

Calculated on 497 KMO children (45% of N = 1108).

* There were three categories of ASHA membership (1) clinicians with CC, (2) Pending (all requirements met except CFY), and (3) clinicians who were not members.

Table 4. K L M O and all "other" learning curves (N = 1108) compared on five clinician variables.

Variable	K n=95		L n=130		M n=130		O n=114		ALL OTHERS n=580		F
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	p
CLIN AGE (23-49)	36.9	7.2	35.2	9.1	32.3	7.2	31.6	7.0	33.6	8.3	<.001
YRS EXP (0-18)	8.4	4.9	7.3	4.1	7.6	4.7	7.8	4.9	7.3	5.2	Non
SELF R (1-15)	12.5	2.2	12.5	2.2	11.9	1.8	12.1	2.3	11.9	2.1	<.01
SELF S (1-15)	12.9	1.7	12.7	2.2	12.2	2.0	12.6	2.4	12.3	1.9	<.05
EOI (93-138)	122.1	8.7	117.3	8.1	118.3	8.7	111.9	10.0	117.9	10.0	<.001

Table 5. Range, mean, standard deviations for all Year IV children on personal characteristic variables. ANOVA performed on the KLMO curve subgroups only.

Variable	Yr IV n = 194			K n = 19		L n = 23		M n = 34		O n = 8		
	Range	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	p
PPVT IQ	68-166	103	15	107	11	105	12	96	14	98	10	.008
Rdg. %tile	1- 99	51	30	63	24	52	29	42	29	38	33	.04
Token	7- 21	16	2.9	17	2.4	14	3.0	15	3.1	15	1.9	.02
Detroit	12- 93	48	16	60	15	46	14	46	16	52	14	.02
GFW %tile	0- 98	26	23	37	20	30	25	23	20	20	20	.09
Tot. Dent.	0- 4	0.97	0.9	1.0	1.0	1.6	0.9	0.8	0.8	0.9	0.9	.04
ODKK	8- 84	45	13	51	11	41	13	44	12	45	16	.07
Tot. Tong. Th.	0- 11	3.0	2.2	3.6	1.8	3.0	2.4	3.0	2.5	1.8	1.2	.29

Table 6. Analysis of Variance Summary, Two Dependent Variables: GAIN and GAMMA by Independent Variables: Sound and baseline score ($SNDEU_1$), Grade, and Previous Therapy. Effects and Standard Errors of Effects.

VARIABLES	GAIN (over 30 wks.)		GAMMA (rate of learning)	
R^2	.40		.15	
F	15.2		3.9	
p (F)	<.001		<.001	
Mean	49.8		6.6	
$SNDEU_1$	Effect	SE	Effect	SE
/s/ low	26.8	2.2	12.9	2.3
/s/ med	15.3	2.1	8.8	2.3
/s/ hi	-21.8	2.3	-5.8	2.5
/r/ low	1.6	2.4	-7.8	2.6
/r/ med	-1.0	2.1	-4.8	2.3
/r/ hi	-21.1	3.7	-4.3	4.1
GRADE				
1	-0.6	2.0	-5.0	2.2
2	-0.6	1.4	-2.1	1.5
3	3.8	1.5	3.8	1.6
4+	-2.6	1.9	3.4	2.0
PREVTH				
NO	1.6	1.0	2.2	1.0
YES	-1.6	1.0	-2.2	1.0

Table 7 The absolute frequency and relative frequency (percent) of activity NAME categories for all clinicians, R and S children, and for all therapy sessions during the year.

	NAME	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)		NAME	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)
0.	Missing Cards	54	0.3				
1. FC	Free Conversa.	2553	13.4	19. NG	Neg. Practice	51	0.3
2. SS	Struc. Speech	902	4.7	20. Sh	Resp. Shaping	223	1.2
3. Rdg	Reading	864	4.5	21. ShD	Directions	22	0.1
4. RA	Review Assignment	449	2.4	22. ShA	Auditory	6	0.0
5. GA	Give Assignment	858	4.5	23. ShV	Visual	6	0.0
6. PP	Parent Participation	7	0.0	24. ShK	Tactual	1	0.0
7. TP	Teacher Participation	0	0.0	25. MD	McDonald Artic. Test	328	1.7
8. PC	Parent Conference	27	0.1	26. TT	Talk Task	1946	10.2
9. TC	Teacher Conference	5	0.0	27. SPT	Sd. Produc. Task	2237	11.7
10. ChT	Chart Time	954	5.0	28. TThD	Tongue Thrust Dental	258	1.4
11. FT	Fun Time	176	0.9	29. VS	Voice/Speech	152	0.8
12. SD	Standard Drill	3856	20.2	30. LB	Lang. Battery	405	2.1
13. GD	Game Drill	1498	7.9	31. GFW	Aud. Discrim.*	93	0.5
14. RD	Rate Drill	168	0.9	32. Combination SM-SS		5	0.0
15. TD	Transfer Drill	130	0.7	33. Combination SD-SM		4	0.0
16. TTh	Tongue Thrust Drill	183	1.0	34. Combination GA-SD		2	0.0
17. Dis	Discrimination	531	2.8	35. Combination TT-SPT		27	0.1
18. SM	Self Monitoring	70	0.4	36. Combination SS-GD		2	0.0
					TOTAL	19053	100.00

*Clinicians did not always indicate on their lesson plan (Activity Cards) "tests" administered once or twice during the school year; consequently, items like #31 (GFW) show fewer cards (93) than total children tested (212).

Table 8 The absolute frequency and relative frequency (percent) of all activity STIMULUS categories for all clinicians, R and S children, and for all therapy sessions during the year.

		NAME	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)
1.	M	Model (auditory)	2316	20.99
2.	P	Picture	2633	23.87
3.	MP	Model Picture	281	2.55
4.	T	Tape Recorder	46	.42
5.	E	Other Equipment	38	.34
6.	O	Objects	12	.11
7.	G.	Graphic	2339	21.21
8.	CG	Child Generated	2823	25.60
9.	SC	Sent. Completion	49	.44
10.	Ch	Chart	234	2.12
11.	GM	Graphic/Model	138	1.26
12.	PG	Picture/Graphic	120	1.09
		TOTAL	11,029	100.00

Table 9 The absolute frequency and relative frequency (percent) of activity CONTENT categories for all clinicians, R and S children, and for all therapy sessions during the year.

	NAME	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)
1. I	Isolation	527	4.87
2. S	Syllable	673	6.21
3. W	Word	3623	33.45
4. Ph	Phrase/Sentence	5845	53.96
5. SW	Syllable-Word	11	.10
6. X	Mixed	48	.44
7. SI	Syllable-Isolation	36	.33
8. WP	Word-Phrase	69	.64
	TOTAL	10,832	100.00

Table 10 The absolute frequency and relative frequency (percent) of activity POSITION categories for all clinicians, R and S children, and for all therapy sessions during the year.

	NAME	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY (PERCENT)
1. I	Initial	1892	17.96
2. M	Medial	341	3.24
3. F	Final	689	6.55
4. X	Mixed	7343	69.71
5. Bl	Blends	268	2.54
	TOTAL	10,533	100.00

Table 11 Clinician and child number for selected K and L /s/ and L and O /r/ learning curves.

/s/				/r/			
K		L		L		O	
Clin.	Child	Clin.	Child	Clin.	Child	Clin.	Child
39	8	41	36	39	1	46	113
39	10	45	92	39	6	48	139
42	46	46	106	40	20	57	406
42	47	46	109	41	40	57	407
44	80	48	142	42	53	59	448
55	217	52	293	48	137	59	449
62	419	52	294	62	417	58	491
56	438	64	507	53	453		
				64	509		

Table 12. Characteristics for eight K /s/ and eight L /s/ children, including average percent GAIN, clinician, child, geography, grade, previous therapy, number in therapy group (GP), Peabody IQ, reading percentile, total raw score on the Token (Subset IV), and Detroit (memory for syllables). All children had therapy twice a week.

K /s/ (n = 8)										L /s/ (n = 8)									
Average GAIN							EU_{1-2} 55.6% EU_{2-3} 31.9% EU_{3-4} 0.6%			2.0% 30.9% 34.0%									
CL #	CH #	Geog.	Gr.	Prev. Th.	NGP	IQ	%tile Rdg.	Tok.	Det.	CL #	CH #	Geog.	Gr.	Prev. Th.	NGP	IQ	%tile Rdg.	Tok.	Det.
39	8	4	3	No	3	116	34	15	49	41	36	4	2	No	3	91	15	13	43
39	10	4	3	No	3	95	58	14	46	45	92	4	1	No	3	98	75	12	45
42	46	4	3	No	2	90	64	18	79	46	106	4	1	No	2	105	30	16	43
42	47	4	3	No	2	114	37	18	37	46	109	4	1	Yes	2	91	41	13	37
44	80	4	4	Yes	2	111	60	19	78	48	142	4	2	No	2	111	72	16	26
55	217	3	2	No	2	110	22	20	46	52	293	3	3	Yes	2	116	89	17	57
56	438	1	4	No	2	98	89	19	64	52	294	3	2	Yes	2	116	93	16	65
62	419	1	1	No	2	127	N/A	18	65	64	507	1	1	Yes	2	101	N/A	9	22
$\bar{X}$						108	52	18	58	$\bar{X}$						104	59	14	42

TAble 13. Percent of activities for K and L learning curves for 16 /s/ children summarized for three time periods: EU1-2, EU2-3, and EU3-4.

TIME	K /s/ n = 8 ACTIVITY NAME										L /s/ n = 8 ACTIVITY NAME									
	FC	SS	Rdg	Cht	SD	GD	DM	SH	Asn	OTH	FC	SS	Rdg	Cht	SD	GD	DM	SH	Asn	OTH
EU 1-2 6 wks	19	3	6	0	41	8	6	2	11	4	10	1	0	12	42	3	4	7	8	11
EU 2-3 12 wks	23	15	11	0	23	13	3	0	5	7	16	2	1	14	32	12	1	1	12	9
EU 3-4 12 wks	34	6	9	13	14	17	0	0	0	5	13	11	8	13	25	10	0	0	11	9

TIME	STIMULUS						CON.		STIMULUS						CON.	
	M	P	MP	G	CG	OTH	Rein	Cost	M	P	MP	G	CG	OTH	Rein	Cost
EU 1-2 6 wks	30	10	2	28	27	3	29	12	63	6	4	2	17	8	37	1
EU 2-3 12 wks	6	31	1	26	35	1	4	5	34	25	10	3	16	12	16	2
EU 3-4 12 wks	4	20	0	20	34	22	22	42	6	31	6	20	32	5	21	10

TIME	CONTENT				POSITION					CONTENT				POSITION				
	I	S	W	Ph	I	M	F	X	Bl	I	S	W	Ph	I	M	F	X	Bl
EU 1-2 6 wks	6	15	41	38	31	6	6	57	0	60	12	24	4	69	0	9	22	0
EU 2-3 12 wks	0	0	18	82	2	3	1	94	0	10	26	33	31	47	2	7	41	3
EU 3-4 12 wks	0	0	0	100	0	0	0	100	0	1	0	45	54	6	2	1	84	7

FC - Free Conversation
SS - Structured Speech
Rdg - Reading
Cht - Charting
SD - Standard Drill
GD - Game Drill

DM - Discrimination
SH - Shaping
ASN - Assignment
OTH - Other Activities

M - Auditory Model
P - Picture
MP - Model & Picture
G - Graphic
CG - Child Generated
OTH - Other

I - Isolation
S - Syllable
W - Word
Ph - Phrase/ Sent.

I - Initial
M - Medial
F - Final
X - Mixed
Bl - Blend

Table 14. Characteristics for none L /r/ and seven O /r/ children include average percent GAIN, clinician, child, geography, grade, previous therapy, number in therapy group (NGP), Peabody IQ, reading percentile, total raw score on the Token (Subtest IV), and Detroit (memory for syllables).

L /r/ (n = 9)										O /r/ (n = 7)									
						EU_{1-2}	3.3%									EU_{1-2}	1.3%		
						EU_{2-3}	35.7%									EU_{2-3}	9.7%		
						EU_{3-4}	34.4%									EU_{3-4}	9.3%		
CL #	CH #	Geog.	Gr.	Prev. Th.	NGP	IQ	Rdg.	Tok.	Det.	CL #	CH #	Geog.	Gr.	Prev. Th.	NGP	IQ	Rdg.	Tok.	Det.
39	3	4	2	No	3	104	50	19	44	46	113	4	3	Yes	2	90	35	17	34
39	6	4	2	Yes	2	90	N/A	16	58	48	139	4	2	No	2	97	N/A	14	12
40	20	4	1	Yes	2	108	77	17	54	57	406	1	3	Yes	2	82	N/A	15	45
41	40	4	3	Yes	2	90	N/A	10	33	57	407	1	1	No	2	100	N/A	17	39
42	53	4	2	No	2	111	11	11	53	58	491	1	3	Yes	2	116	82	17	75
48	137	4	3	Yes	2	108	30	17	69	59	448	1	2	No	2	102	35	14	70
62	417	1	1	No	2	121	N/A	13	42	59	449	1	3	No	2	97	11	14	56
59	453	1	4	Yes	2	112	8	19	61										
64	509	1	2	Yes	2	102	86	8	39										
$\bar{X}$						105	44	14	50	$\bar{X}$						98	41	15	47

Table 15. Percent of Activities for L and O learning curves for 16 /r/ children summarized for three time periods: EU1-2, EU2-3, EU3-4.

TIME	L /r/ n = 9										O /r/ n = 7									
	ACTIVITY NAME										ACTIVITY NAME									
	FC	SS	Rdg	Cht	SD	GD	DM	SH	ASN	OTH	FC	SS	Rdg	Cht	SD	GD	DM	SH	ASN	OTH
EU 1-2 6 wks	13	3	0	3	53	1	7	8	8	4	19	2	1	8	29	10	8	6	17	0
EU 2-3 12 wks	17	3	2	6	39	15	0	0	12	6	21	1	0	9	27	21	2	1	13	5
EU 3-4 12 wks	23	7	11	12	21	11	0	0	10	5	24	3	0	6	27	17	1	1	17	4

TIME	STIMULUS						CON.		STIMULUS						CON.	
	M	P	MP	G	CG	OTH	Rein	Cost	M	P	MP	G	CG	OTH	Rein	Cost
EU 1-2 6 wks	41	8	15	12	19	5	21	5	45	10	3	18	23	1	19	6
EU 2-3 12 wks	10	41	5	11	25	8	26	13	30	14	4	14	32	6	18	4
EU 3-4 12 wks	3	35	0	24	31	7	16	7	30	13	2	21	27	7	25	13

TIME	CONTENT				POSITION					CONTENT				POSITION				
	I	S	W	Ph	I	M	F	X	BI	I	S	W	Ph	I	M	F	X	BI
EU 1-2 6 wks	27	30	34	9	64	2	11	22	1	14	12	47	27	47	5	0	47	1
EU 2-3 12 wks	1	7	58	34	27	7	16	50	0	6	13	40	41	49	4	6	41	0
EU 3-4 12 wks	0	0	25	75	4	4	1	78	13	3	9	42	46	31	8	13	44	5

FC - Free Conversation
SS - Structured Speech
Rdg - Reading
Cht - Charting
SD - Standard Drill
GD - Game Drill
DM - Discrimination
SH - Shaping
ASN - Assignment
OTH - Other Activities
M - Auditory Model
P - Picture
MP - Model & Picture
G - Graphic
CG - Child Generated
OTH - Other
I - Isolation
S - Syllable
W - Word
Ph - Phrase/ Sent.
I - Initial
M - Medial
F - Final
X - Mixed
BI - Blend

Table 16 Summary means for the amount of time (in minutes), number of therapy sessions, and number of different therapy activities, spent by each learning curve group for the three blocks of time EU1-2, 2-3, and 3-4 during the school year.

	K /s/ N = 8			L /s/ N = 8			L /r/ N = 9			O /r/ N = 7		
	Time	Sess	Act	Time	Sess	Act	Time	Sess	Act	Time	Sess	Act
EU1-2 6 wks.	113	8	17	127	8	17	122	8	22	232	12	30
EU2-3 12 wks.	173	10	21	200	11	26	183	11	25	203	12	26
EU3-4 12 wks.	118	8	17	222	14	30	269	13	35	288	16	41
Total	404	24	55	549	33	73	574	32	82	723	40	97
Time	6.9 hrs.			9.2 hrs.			9.6 hrs.			12.1 hrs.		
$\bar{X}$ Time		17	7		17	8		18	7		18	7
$\bar{X}$ Act/Sess			2.3			2.2			2.6			2.4

Table 17. Distribution of clincians and children by learning curve analyzed for therapy interactions on the Tone Keyboard.

K			L			M		
Clin.	Child	Sd.	Clin.	Child	Sd.	Clin.	Child	Sd.
39	5	/r/	39	3	/r/	35	2	/r/
39	8	/s/	39	6	/r/	42	48	/r/
42	46	/s/	42	52	/r/	48	138	/r/
42	47	/r/	42	53	/r/			
			48	137	/r/			
			48	142	/s/			

Table 18. Total number of clinician antecedent events (AE), child responses, and clinician subsequent events (SE), for four K, six L, and three M children reduced to the three time periods: EU 1-2 (first six weeks), EU 2-3 (next 12 weeks), and EU 3-4 (last 12 weeks) during the school year. The frequency of the event is above the line, percentage below the line, each row totals 100%

	CLINICIAN AE AG F V	Model	CHILD RESPONSE V DM Z	+ / -	CLINICIAN SE + / -	TOTAL EVENTS
EU 1-2						
K	99 / 3	329 / 11	8 / 1	2017 / 70	440 / 15	2893
L	243 / 6	817 / 21	39 / 1	1682 / 44	1082 / 28	3863
M	129 / 11	212 / 19	36 / 2	464 / 41	304 / 27	1145
EU 2-3						
K	35 / 2	25 / 1	3 / 0	1338 / 75	335 / 22	1786
L	226 / 8	181 / 6	50 / 2	1780 / 62	631 / 22	2868
M	143 / 12	48 / 4	68 / 6	666 / 55	297 / 24	1222
EU 3-4						
K	40 / 2	3 / 0	3 / 0	1562 / 89	156 / 9	1764
L	416 / 9	141 / 3	78 / 2	3171 / 72	598 / 14	4404
M	175 / 10	55 / 3	3 / 0	1340 / 80	119 / 7	1692
TOTAL FOR THE YEAR						
K	174 / 3	357 / 6	14 / 0	4917 / 76	981 / 15	6443
L	885 / 8	1139 / 10	167 / 1	6633 / 60	2311 / 21	11, 135
M	447 / 11	315 / 8	107 / 2	2470 / 61	720 / 18	4059
GRAND TOTAL						
	1506 / 7	1811 / 8	289 / 1	14, 019 / 65	4012 / 19	21, 637

Table 19. The percent of clinician and child events for K L M learners. Each row represents 100% of the events for each category: Clinician AE, child response, and clinician SE. The reinforcement (C+/K+) and punishment (C-/K-) ratios are also indicated.

	CLIN. AE							CHILD RESPONSE						CLIN. SE			RATIO	RATIO
	AG	F	V	I	S	W	Ph	V	DM	Z	+	/	-	+	/	-	C+/K+	C-/K-
EU12																		
K	37	20	43	1	7	85	7	0	0	0	92	1	7	83	5	12	20	38
L	35	24	41	17	32	43	8	1	1	0	80	5	13	78	7	15	62	69
M	43	14	43	6	72	22	0	2	0	5	55	9	29	62	14	24	69	50
EU23																		
K	15	31	54	0	0	100	0	0	0	0	92	2	6	82	4	14	26	67
L	6	18	51	4	30	66	0	1	1	0	88	2	8	82	7	11	32	50
M	34	8	58	0	4	90	6	6	4	0	83	1	6	84	6	10	41	69
EU34																		
K	38	20	42	0	0	100	0	0	0	0	98	0	2	95	0	5	10	21
L	28	21	51	3	1	91	5	1	1	0	90	1	7	79	6	15	16	37
M	22	10	68	0	2	64	34	0	0	0	89	2	9	50	13	37	5	37

AG=Again
F=Feedback
V=Verbalization

I=Isolation
S=Syllable
W=Word
Ph=Phrase/Sent

V=Verbalization
DM=Discrimination
Z=Self-correction

+=Correct
/=Approximation
-=Wrong

C+=Clinician+
K+=Child+

Table 20. The total amount of time (minutes) recorded for each therapy session on the Tone Keyboard (TKB) for three learning groups K L M. Rates per minute have been computed for all events, antecedent events (AE), child response, and subsequent event (SE).

	Total Time	Total TKB Sess	All Events Per Min	AE Per Min	Child Response Per Min	SE Per Min
EU12						
K	361	26	8.0	1.2	5.6	1.2
L	520	36	7.4	2.0	3.3	2.1
M	167	15	6.9	2.1	3.0	1.8
EU23						
K	304	23	5.9	0.2	4.4	1.3
L	405	27	7.1	1.0	4.5	1.6
M	210	19	5.8	0.9	3.5	1.4
EU34						
K	290	18	6.1	0.2	5.4	0.5
L	623	48	7.1	0.9	5.2	1.0
M	207	29	8.2	1.1	6.5	0.6
Grand $\bar{X}$			7.0	1.1	4.6	1.3

Table 21. The time interval in seconds between two behavioral events punched on the Tone Keyboard. Data is summarized for mean percent and accumulated (ACC) percent of events that occurred between intervals up to 10 seconds for four clinicians. Anything greater than a 10 second interval was printed out as 11+.

TOTAL Therapy Sessions		Intervals measured in seconds											
		0	1	2	3	4	5	6	7	8	9	10	11^+
75 sessions clin. 42	$\bar{X}$	19	34	15	7	5	3	2	2	2	2	1	8
	ACC	19	53	68	75	80	83	85	87	89	91	92	100
66 sessions clin. 48	$\bar{X}$	7	28	19	10	6	4	4	3	3	3	1	12
	ACC	7	35	54	64	70	74	78	81	84	87	88	100
16 sessions clin. 25	$\bar{X}$	16	32	14	10	6	4	3	2	2	3	1	7
	ACC	16	48	62	72	78	82	85	87	89	92	93	100
23 sessions clin. 41	$\bar{X}$	13	36	18	8	6	3	2	2	2	2	1	7
	ACC	13	49	67	75	81	84	86	88	90	92	93	100

Table 22. The number of children from a caseload of 996 (/r/ and /s/) who could be dismissed from speech therapy throughout the school year when dismissal criteria based upon a Unified Score (SPT + Talk) are specified.

Dismissal Criteria	75% Correct			85% Correct			95% Correct		
	Percent	N	Total	Percent	N	Total	Percent	N	Total
Baseline	9	105	105	5	65	65	.5	12	12
6 weeks	29	108	213	10	70	135	1	14	26
18 weeks	46	270	483	35	248	383	8	150	176
30 weeks	64	184	667	53	178	561	24	210	360

Table 23. The number of 307 /s/ and 277 /r/ children who had other errors on the McDonald Test. Chi Square and p values are also reported.

	/tʃ/	/θ/	/ʃ/	/l/
/s/	123	130	136	54
/r/	65	95	87	80
X^2	9.89	1.94	4.89	6.29
p	.01	Non	.05	.02

Note: Any /s/ or /r/ child could have more than one phoneme in error.

Table 24. The number of 307 /s/ and 277 /r/ children who had errors on other phonemes and those who improved after treatment during the school year on the post therapy McDonald Test.

	/tʃ/		/θ/		/ʃ/		/l/	
	Improve	No	Improve	No	Improve	No	Improve	No
/s/	94	29	90	40	105	31	39	15
/r/	49	16	72	23	65	22	56	24
X^2	0.02*		1.17		0.18		0.08	

*All Chi Squares were nonsignificant.

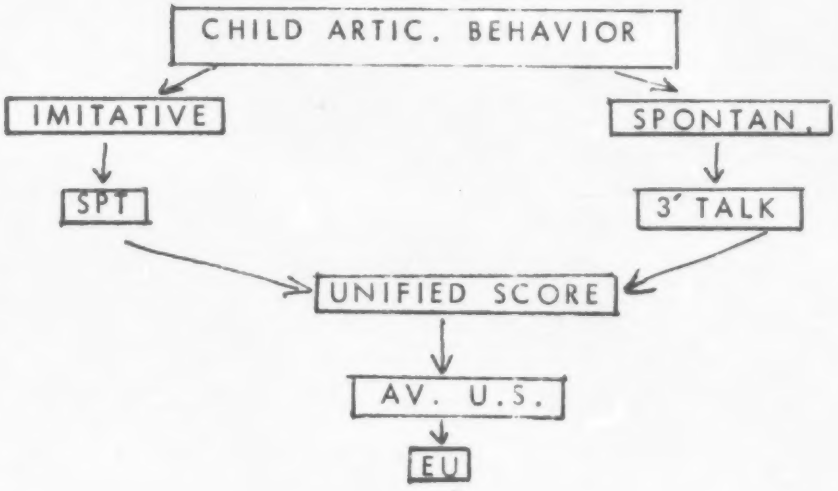
Table 25

Percent of 115 /r/ and 138 /s/ children in different learning categories (KLMO) who have other phoneme errors* on the McDonald Test. The percent of frontal and lateral /s/ is indicated for each curve for all /s/ children.

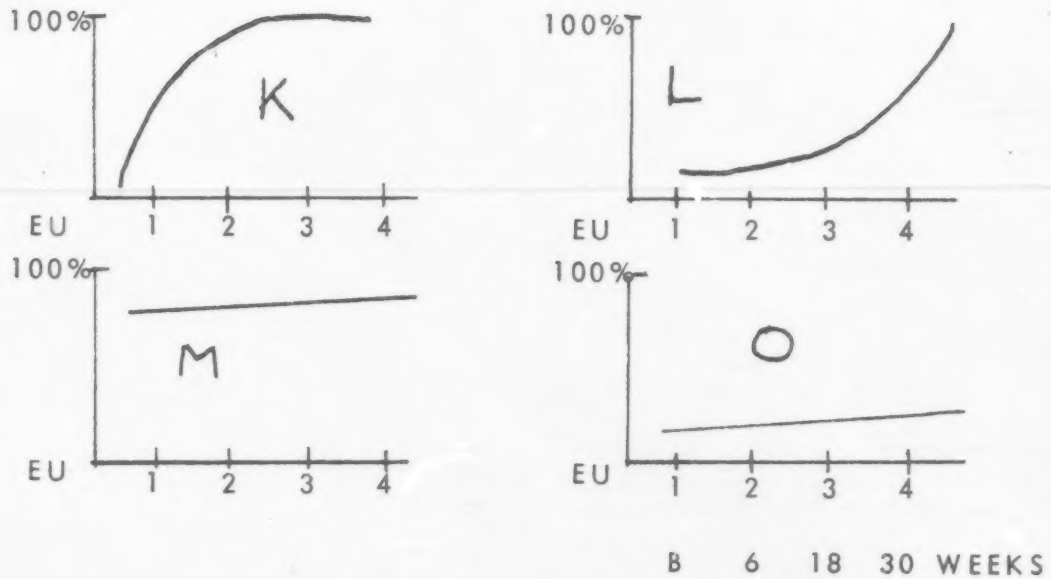
		/l/	/r/	/θ/	/ʃ/	/tʃ/	/f/	/k/	/t/	frontal	Lateral or other
/s/	K (n = 50)	0%	4	20	26	16	0	0	0	80%	20%
	L (n = 35)	11	20	57	37	37	6	3	0	71	29
	M (n = 40)	0	10	13	22	20	0	0	0	60	40
	O (n = 13)	8	23	54	69	46	0	0	0	54	46

		/l/	/s/	/θ/	/ʃ/	/tʃ/	/f/	/k/	/t/
/r/	K (n = 11)	0 %	18	18	0	0	0	0	0
	L (n = 34)	18	21	26	24	15	6	3	0
	M (n = 32)	3	9	28	9	3	0	0	3
	O (n = 38)	18	29	47	39	24	3	3	0

*Each phoneme is tested ten times. If the child got less than three wrong on any given phoneme he was not included in the tally. Any given child might have had more than one phoneme in error.



DEPENDENT VARIABLES



GAIN EU_4-EU_1

GAMMA 3+2-4-1

LEVEL Av. of EU_{1234}

Figure 1.

Structure of the Dependent Variables

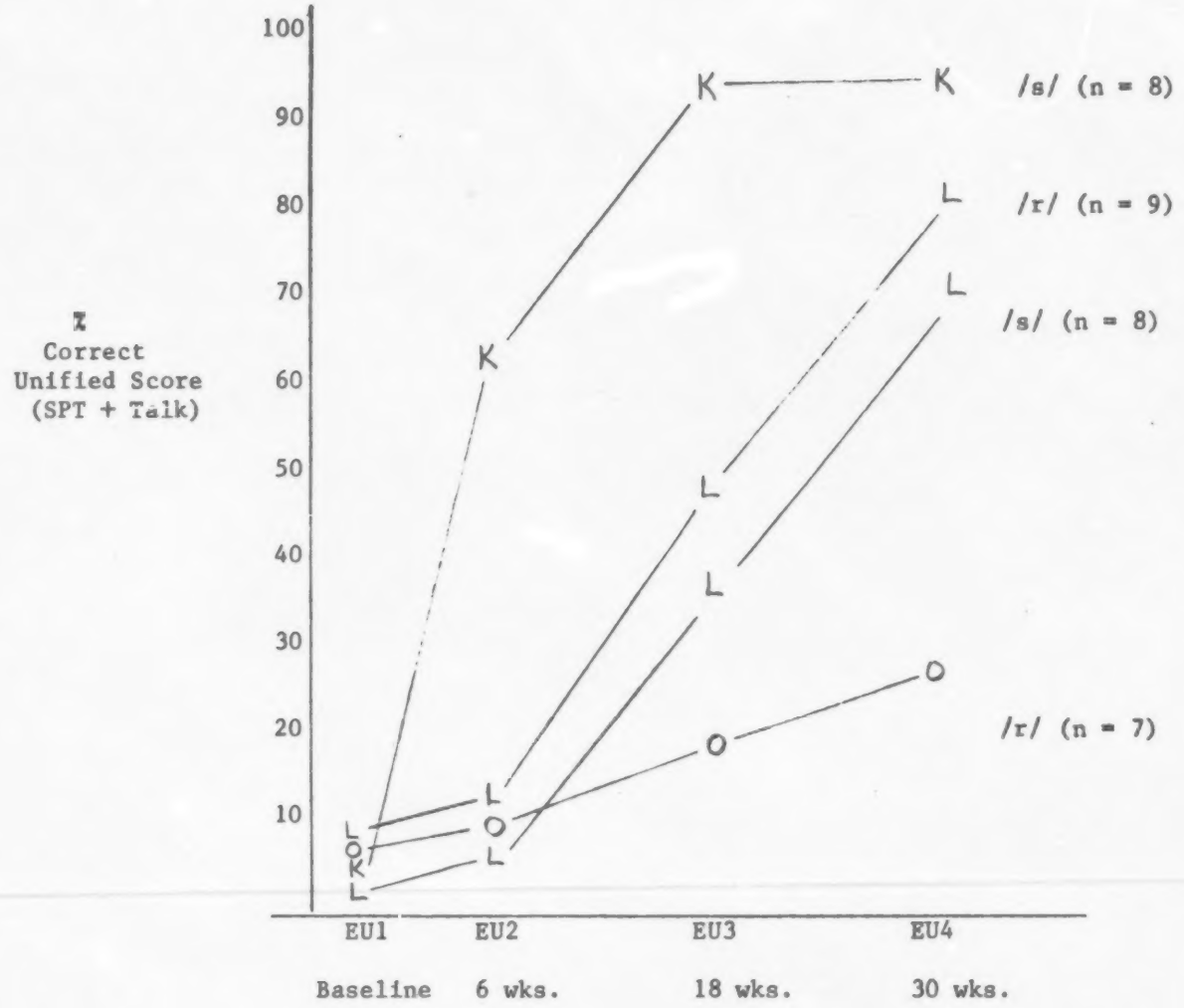


Fig. 2. Illustrates average K L O curves for selected /s/ and /r/ children whose lesson plans were analyzed for the year.

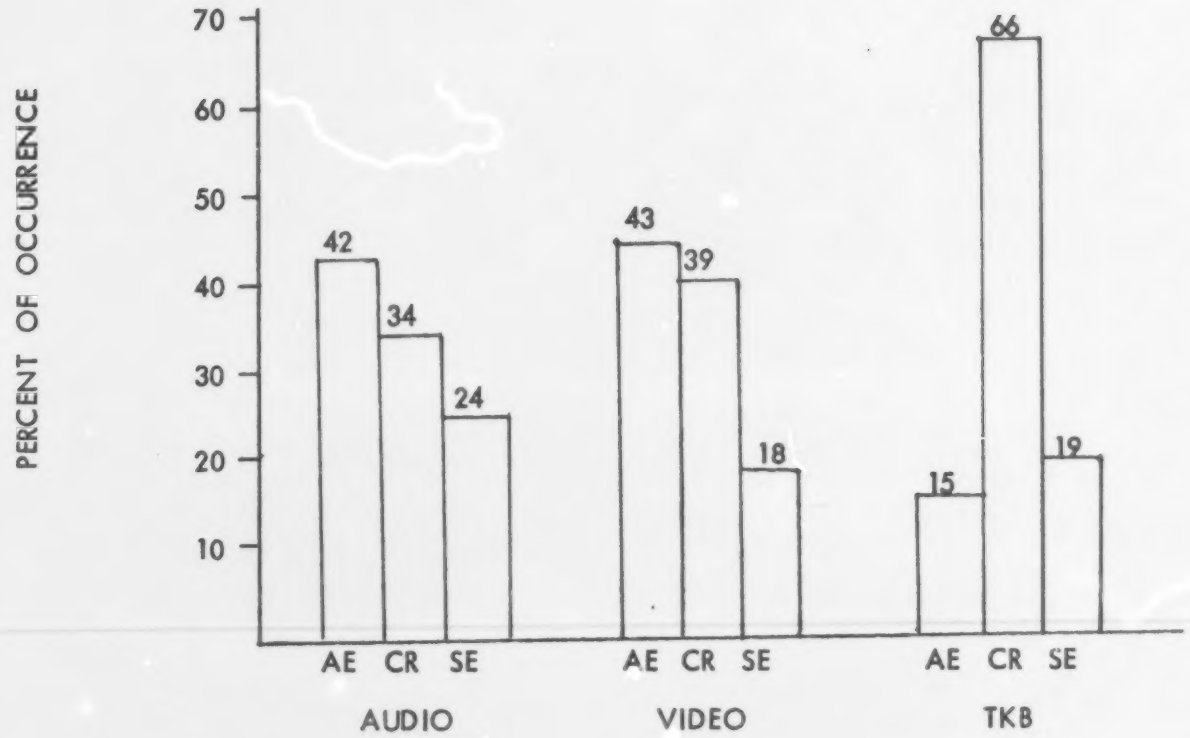


Fig. 3 . Bar diagram contrasts the percent frequency of occurrence of antecedent event (AE), child response (CR), and subsequent even (SE) described in the Lingwall-Engmann (1971) audio tape and video tape analysis with the ToneKeyboard (TKB) data collected in this study.